



# CONSTRUCTION TESTING & ENGINEERING, INC.

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**CEQA Drainage Study**  
For  
TM 5401RPL<sup>3</sup>; ER 04-08-036

**Project Location:**  
1050 Ora Avo Drive  
San Diego, CA  
APN: 181-161-11 & 181-260-00

**Prepared For:**  
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CTE Job No. 10-5570

February 26, 2009

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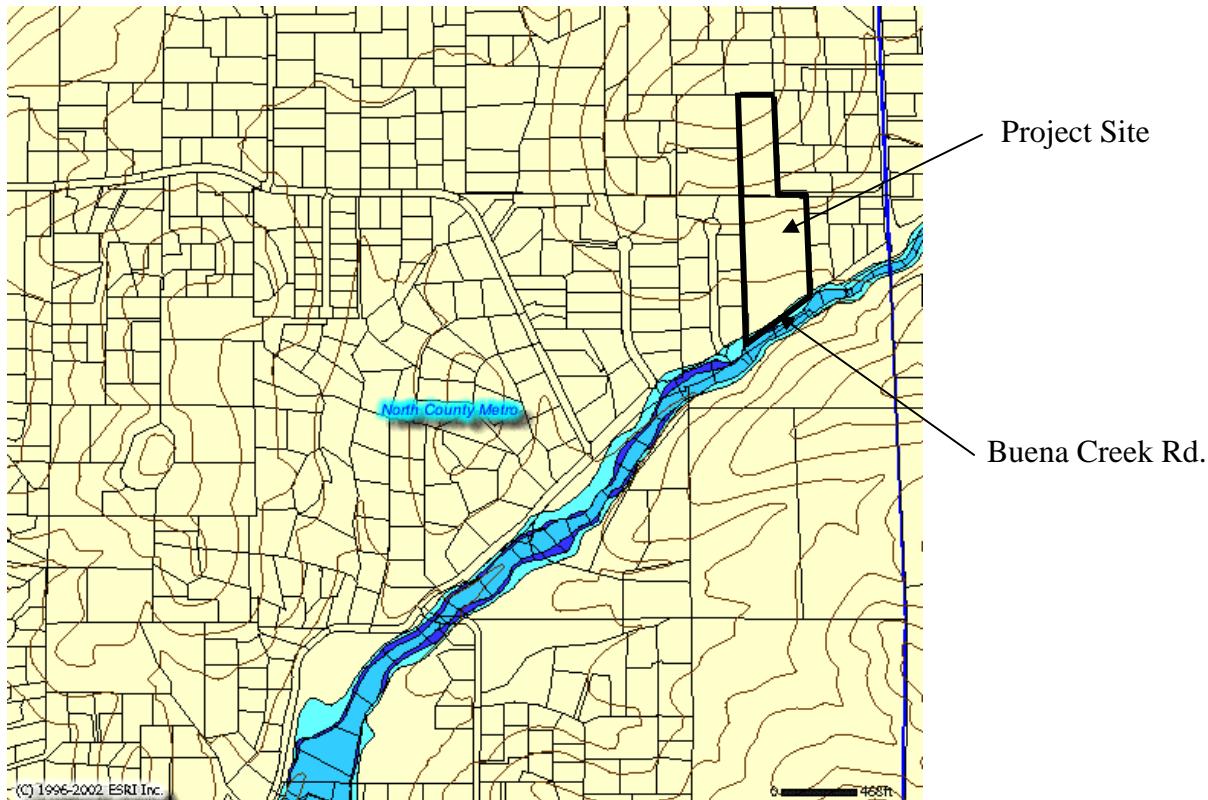
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## **PURPOSE**

To calculate 100-year flows, perform preliminary drainage design and check capacities of any existing drainage structures as necessary for the proposed project. The development proposes to subdivide two lots totaling 10.27 acres into eight separate parcels for the construction of eight single-family residences. Utilities, drainage structures, driveways and an access road shall also be constructed. In addition, two existing structures shall be demolished.

## **LOCATION**



The development site is located at 1050 Ora Avo Drive. Buena Creek Road borders the project to the south. The closest cross streets are Starview Drive to the west and Ora Avo Drive to the east.

## **SITE HYDROLOGY**

### ***Offsite Conditions***

Offsite storm water enters the site from the east on Buena Creek Road. The offsite area is approximately 1.15 acres. The amount of storm water runoff flowing onto the site is 2.55cfs. This area is represented by offsite basin 2. In addition, several backyards to the west of the site enter onto the site. The size of this offsite basin is 0.26 acres and 0.68cfs runoff enters the site. This area is represented by offsite basin 1. A total of 2.45cfs of runoff generated from a northeastern offsite basin of 0.94 acres in area. This area is represented by offsite basin 3.

An existing private access road directs the runoff from the northeast away from the site to the east. A hydraulic calculation indicates the existing road has a maximum carrying capacity of 5.96cfs prior to critical height exceeding the 4" ac lip (see hydraulic calculations section). This is greater than the total flow entering from the northeast; therefore no storm water runoff enters the site.

The topography for the offsite areas contributing to the project was obtained from the Counties 200-scale topography maps. The Hydrology Map-offsite basins are located within Appendix 4. Offsite flows are summarized within Table 1 below.

**Table 1**

Enter Site SE Corner; Buena Creek Road (offsite basin 2)	2.55cfs
Enter Site South West Edge (offsite basin 1)	0.68cfs
Enter Site from Northeast (offsite basin 3)	2.45cfs

Southeast of Buena Creek Road is Buena Creek. It flows to the west southwest. The 100-year flood water levels range from an elevation of 585.17 at section 11.179 to 594.53 at section 11.226. The sections are per County flood plain map 370-1707 and were determined per a HEC-2 analysis dated November 15, 1978. 100-year flood levels range from 1 to 2 feet below the existing grade of Buena Creek Road. The flood plain information is shown on the Developed Conditions Hydrology Map in Appendix 2. The backup calculation for HEC-2 analysis dated 11/15/1978 has been attached in Appendix 7.

#### ***Existing Developed Conditions***

The project site was an active farm with fields and farm structures. The project is located on the south face of a hill. The hilltop is just offsite to the northwest. The project slopes from approximately 20% on the top to less than 5% at the bottom. An earthen Berm surrounds the project at the property line and allows no storm water to enter the site or to leave the site except as noted. The southwest edge is the only location where the Berm is not present and the backyards of several residences enter into the site from here. Small earth drainage swales are approximately 10 feet from the property line along the eastern, western and southern edges and convey any runoff that fails to sheet flow. The eastern half of the site drains to the center of the south edge of the site where it exits through a gap in the Berm and flows down a 3-foot slope onto Buena Creek Road. The western half of the site exits at the southwest corner of the project. Water exits down a small dirt ramp onto the beginning of the widened section of Buena Creek Road. All the runoff then flows along the Buena Creek Road to an existing Curb Inlet and then drain into Buena Creek through a culvert.

Topography for the site was obtained from an aerial survey performed by TMR Associates, Inc. on November 11, 2002. The survey confirms the existing 200-scale County Topography map but is more up to date and detailed. Existing drainage features were noted by site visit and by conducting Topographic Survey by CTE personnel. The eastern half of the project site is represented by existing basins 1, 2 & 3. The western half of the site is represented by existing basins 5 & 6. Buena Creek Road is represented by existing basins 4 & 7. The hydrology map existing condition may be found within Appendix 3. Existing flows are summarized in Table 2 below.

**Table 2**

Middle of Southern Edge	9.06cfs
Southwestern Corner	11.68cfs
Leave site on Buena Creek Road	21.49cfs

***Proposed Developed Conditions***

The site will be bisected by an access road. Eight residential pads will be constructed, one at the north end of the project, four west of the road and three east of the road. The four western pads, lots 1, 2, 3 & 4, will drain to the southwestern corner of the project. The Private road and the portion of lot 1 & lot 8 shall drain to a storm drain located on the southern edge of the project that will empty into the southwestern corner of the project. A culvert shall take runoff from the southwestern corner of the project and outfall into Buena Creek just south of Buena Creek Road. Stormwater runoff from the eastern edge of the project and the northern pad, lots 5, 6, 7 & 8 will drain to the southeastern corner. From there, through Brow Ditch, runoff enters into a proposed storm drain that flows towards the proposed culvert at the southwest corner of the project. Runoff from northerly half of Buena Creek Road shall flow through proposed ac Berm into the proposed curb inlet which will drain in to the aforementioned culvert. The culvert then empties into Buena Creek. Sizing and culvert calculations may be found within the hydraulic calculations section of the report.

Grading and drainage for the proposed development were obtained from the proposed tentative map grading plan. The western portion of the site is represented by proposed basins 1-10a while the access road is represented by proposed basins 11 & 12. The eastern portion of the site and the northern pad are represented by proposed basins 13-20b. Buena Creek Road, after it has been improved, is represented by proposed basin 21. The hydrology map proposed condition may be found within Appendix 2. Propose flows are summarized within Table 3 below.

**Table 3**

Southwestern Culvert	23.55cfs
Leave site on Buena Creek Road	0.0cfs

**METHODOLOGY**

***Assumptions***

1. Flow calculations per San Diego County Hydrology Manual (2003).
2.  $n = 0.015$  for concrete brow ditches and concrete lined swales;  $n = 0.013$  for PVC and RCP pipe;  $n = 0.060$  for grassy swales;  $n = 0.015$  for Concrete Gutters;  $n = 0.015$  for AC Street with AC Berm smooth finish;  $n=0.016$  for AC rough texture,  $n = 0.040$  for riprap lined swales and  $n = 0.023$  for earthen swale (clayey) per the San Diego County Drainage Design Manual. See Appendix 6.
3. Hydrologic Soils Group “C” & “D” per the San Diego Soils Survey.
4.  $P_6 = 3.5$  in/hr and  $P_{24}=6.0$  in/hr per Isopluvial Maps found within the San Diego County Hydrology Manual (2003).

### ***Discussion***

Hydrologic calculations were performed per methods as outlined within the San Diego Hydrology Manual (2003). The hydrology calculations for offsite, proposed and existing conditions may be found within the hydrology calculations section of this report. Hydraulic calculations for velocity checks, capacity and sizing were performed using the Autodesk® Land Development 2005 suite and Manning's equation. The culvert capacity calculations were found using the chart from the San Diego County Drainage Design Manual 2005.

The precipitations for 6 hour and 24 hour 100-year storms were determined using the Isopluvial Maps. Those maps have been included as Appendix 1. The hydrologic soils groups were found to be type "C" or "D" per the San Diego Soils Survey. See Appendix 5 for the relevant maps. The coefficient of runoff "C" was found from the San Diego County Hydrology Manual Table 3-1 or calculated using the formula on page 3-2. In areas where different coefficients of runoff were within a particular basin a weighted average was found.

## **SUMMARY**

### ***Capacity/Sizing Calculations***

Capacity/Sizing Calculations may be found within the Hydraulic Calculations section of the report. The results are summarized below.

DS-1	Vegetated swale @ 5.75% (B=10' X-Slope 3:1)	58% full	V = 2.4 fps
DS-2	Riprap lined swale @ 19.1% (B=5' X-Slope 3:1)	23% full	V = 3.7 fps
DS-3	Vegetated swale @ 9.55 % (B=5' X-Slope 3:1)	52% full	V = 2.8 fps
DS-4	Vegetated swale @ 4.3% (B=5' X-Slope 3:1)	83% full	V = 2.5 fps
SD-1	24"RCP @ 1%	73% full	V = 8.1fps
SD-2	18" PVC @ 3.9%	50% full	V = 11.8 fps
SD-3	18" PVC @ 1%	69% full	V= 6.6 fps
BERM 1	AC Berm (Smooth Finish) @ 3.47%	38% full	V = 3.8 fps
CULVERT 1	36" RCP @ 0.5%	50% full	V = 6.7 fps

### ***Conclusion***

The total flow leaving the site in the existing developed conditions was 21.49cfs. The total flow leaving the site in the proposed developed conditions is 23.55cfs. This is a difference of 2.06cfs. This difference is due to an increase in imperviousness due to the new access road and the proposed residences and the proposed widening of Buena Creek Road. The increase in flow was mitigated by out falling it into Buena Creek. The flow on Buena Creek Road is being intercepted by the proposed Curb Inlet at the south-westerly property boundary and thus the flow leaving the site was reduced from 21.49cfs to 0.0cfs. In addition, the road is being widened in front of the project, which will reduce flooding of the travel lanes. Please note that the increased flow in Buena Creek of 23.55cfs which outfalls via the proposed culvert is not a major change in drainage patterns because there is an existing culvert, which empties into Buena Creek only a few hundred feet downstream. Therefore, the total increase on Buena Creek will be 2.06cfs. The total flow in Buena Creek from the HEC-2 analysis dated Nov. 15, 1978 is 2500cfs.

Therefore the total increase will be 0.08%;  $[((2500+2.06)/2500)-1] \times 100\%$ .

Because the total increase in peak runoff in Buena Creek is so small there will be no appreciable impact on Buena Creek. The downstream drainage structures, culverts, bridges, etc. will also see a negligible impact from the increase in peak runoff. The existing 100-year storm line of inundation was plotted on the grading plan and the proposed condition hydrology map. The inundation line was found to be below the existing grade of Buena Creek Road. Since the improvements being made to Buena Creek Road are on the opposite site of the road from there will be no impacts on the line of inundation.

The proposed RCP Culvert at the south-western project boundary expected to have minimum impact on the bank of the Buena Creek. To locate the outfall location of the proposed culvert, CTE, Inc. conducted a topographic survey at the vicinity of the proposed outfall and the Buena Creek. The approximate location of the culvert, headwall and the riprap at the end of the culvert can be found in the drawing "Hydrology Map Develop Condition" and in project grading plan. The culvert will release storm water at the rate of maximum 23.55cfs with velocity of 6.7fps. A properly sized Riprap shall be placed at the end of the Headwall to mitigate any potential erosion at the out fall location. As shown on the drawing that all these proposed structures can be placed without damaging any existing tree and can be placed within the public right-of-way. Thus no further mitigation is needed.

The impact of sedimentation from this project is expected to be minimal because the development is currently entirely exposed disturbed soil. The proposed development will cover virtually all the development with either pavement, structures or irrigated landscaping and control all runoff using designed drainage structures. All other potential pollutants from the project will be handled using post construction BMPs as detailed within the SWMP.

CEQA Drainage Study  
TM 5401RPL<sup>3</sup>; ER 04-08-036  
Vista, California  
February 26, 2009

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#### **REFERENCES**

- “Best Management Practices for Erosion and Sediment Control & Storm Water Retention/Detention” San Diego County Association of Resource Conservation District Spring 1998
- “Drainage Design Manual” San Diego County May 2005
- “Revised Grading Ordinance” San Diego County May 9, 2003
- “San Diego Area Regional Standard Drawings” County of San Diego Department of Public Works March 2000
- “San Diego County Hydrology Manual” County of San Diego Department of Public Works Flood Control Section June 2003
- “San Diego Soils Interpretation Study Hydrologic Soils Group – Runoff Potential” San Diego County Planning Department for the Comprehensive Planning Organization 1969

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**DECLARATION OF RESPONSIBLE CHARGE**

I, hereby declare that I am the Engineer of Work for this project, that I have exercised responsible charge over the design of the project as defined in section 6703 of the business and professions code, and that the design is consistent with current standards.

I understand that the check of project drawings and specifications by the County of San Diego is confined to a review only and does not relieve me, as Engineer of Work of my responsibility for project design.

**ENGINEER OF WORK:**

Construction Testing and Engineering, Inc.  
1441 Montiel Road, Suite 115  
Escondido, CA 92026



2-26-09

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Moyenuddin A. Sirajee  
R.C.E. 63867  
Exp. 9-30-10

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Date



## **HYDROLOGY CALCULATIONS**

## **Existing Conditions**

TM 5401  
Existing Basin 1

Rational Method  
100 Year Storm

1 AREA (A) = 10466.64 sq.ft. = 0.24 ACRES  
2 COEFFICIENT OF RUNOFF (C) COEFFICIENT "C"

LAND USE <u>NRCS ELEMENTS</u>	<u>DENSITY</u>	<u>% BASIN</u>	<u>% IMPERV.</u>	=	
UNDISTURBED NATURAL	OPEN	100	0	=	0.35
LOW DENSITY RESIDENTIAL	1.0 DU/A	0	10	=	0.41
LOW DENSITY RESIDENTIAL	2.0 DU/A	0	20	=	0.46
LOW DENSITY RESIDENTIAL	2.9 DU/A	0	25	=	0.49
MEDIUM DENSITY RESIDENTIAL	4.3 DU/A	0	30	=	0.52
MEDIUM DENSITY RESIDENTIAL	7.3 DU/A	0	40	=	0.57
MEDIUM DENSITY RESIDENTIAL	10.9 DU/A	0	45	=	0.60
MEDIUM DENSITY RESIDENTIAL	14.5 DU/A	0	50	=	0.63
HIGH DENSITY RESIDENTIAL	24 DU/A	0	65	=	0.71
HIGH DENSITY RESIDENTIAL	43.0 DU/A	0	80	=	0.79
COMMERCIAL/INDUSTRIAL	NEIGH.	0	80	=	0.79
COMMERCIAL/INDUSTRIAL	GEN. COM.	0	85	=	0.82
COMMERCIAL/INDUSTRIAL	OFFICE	0	90	=	0.85
COMMERCIAL/INDUSTRIAL	LIMITED	0	90	=	0.85
COMMERCIAL/INDUSTRIAL	GEN. IND.	0	95	=	0.87
PERCENT IMPERVIOUS		0	100.00	=	0.90
SOIL GROUP	<u>D</u>		CA = <u>0.08</u>	C = <u>0.35</u>	

3 TIME OF CONCENTRATION (TC) - SHEET FLOW

$$\begin{aligned} \text{HIGH POINT (Hh)} &= \underline{\underline{789.5}} & \text{LOW POINT (Hl)} &= \underline{\underline{780.21}} \\ H = Hh - Hl &= \underline{\underline{9.29 \text{ ft.}}} & S &= \underline{\underline{9.3\%}} \\ L &= \underline{\underline{100.08 \text{ ft.}}} \\ L_M &= \underline{\underline{100.00 \text{ ft.}}} & \text{FROM TABLE 3-2.} & & & \underline{\underline{0.02 \text{ MILES}}} \\ T_i &= \underline{\underline{6.47 \text{ MIN}}} \end{aligned}$$

4 INTENSITY (I) FOR FREQUENCY YEAR 100

SEE ATTACHMENT 1 FOR PRECIPITATION MAPS FROM THE SAN DIEGO COUNTY HYDROLOGY MANUAL

$$\begin{aligned} A) P_6 &= \underline{\underline{3.5}} & P_{24} &= \underline{\underline{6.0}} & P_6/P_{24} &= \underline{\underline{58.3\%}} \\ B) & & P_6(\text{ADJUSTED}) &= \underline{\underline{3.5}} \\ C) I &= \underline{\underline{7.81 \text{ IN/HR}}} \quad (I = 7.44 P_6 (T_C)^{-0.645}) \end{aligned}$$

5 RUNOFF (Q)

$$Q = CIA = \underline{\underline{0.66 \text{ cfs}}} \quad \text{Node 1-1 to 1-2}$$

**Node -1-2 to 1-3*****Ex. Basin 2*****Data**

P <sub>6</sub> =	3.5 in	
P <sub>24</sub> =	6.0 in	
Area_Ex. Basin 2 (acres)	2.34	
Area_Ex. Basin 1 (acres)	0.24	Upstream
C_Ex. Basin 2	0.35	See Below
CA_Upstream	0.08	Upstream

**Ex. Basin 2**

High point	780.21	
Low point	655.90	
Distance	612.50	Slope= 0.2030 20.30%

**Ex. Node 1-2**

T <sub>i</sub> (min)	6.47	Upstream
I (in/hr)	7.81	CA_Ex. Basin 2= 0.82
Q Node 1-2	0.66	CA_Upstream= 0.08 SUM CA= 0.90

Final Area= 2.58 acres

T <sub>t</sub> (Kirpich's)	Overland Flow	T <sub>t</sub> = $(11.9 \cdot L^3 / (H_p - L_p))^{0.385}$
T <sub>c</sub> =T <sub>i</sub> +T <sub>t</sub>	Figure 3-4	<u>Summary</u>
I (7.44P <sub>6</sub> (T <sub>c</sub> ) <sup>-0.645</sup> ) =	1.98 min	Q Node 1-3= 5.94 cfs
	8.45 min	I= 6.57 in/hr
Q Node 1-3=	6.57 in/hr	T <sub>c</sub> = 8.45 min
	5.94 cfs	Sum CA= 0.90
		Area= 2.58 acres

Land Use Element =	Natural	From Table 3-1
Percentage of Basin =	100.00%	C = <u>0.35</u>
Percent Impervious =	0.00%	From Formula Page 3-5
Percentage of Basin =	0.00%	C = <u>0.35</u>
Hydrologic Soil Group =	D	
Coefficient of Runoff =	<u>0.35</u>	Proportionate Average

**Node -1-3 to 1-5*****Ex. Basin 3*****Data**

P <sub>6</sub> =	3.5 in	
P <sub>24</sub> =	6.0 in	
Area_Ex. Basin 3 (acres)	2.19	
Area_Node 1-3 (acres)	2.58	Upstream
C_Ex. Basin 3	0.36	See Below
CA_Upstream	0.90	Upstream

**Ex. Basin 3**

High point	655.90	
Low point	594.13	
Distance	734.43	Slope= 0.0841 8.41%

**Ex. Node 1-3**

Ti (min)	8.45	Upstream
I (in/hr)	6.57	CA_Ex. Basin 3= 0.79
Q Node 1-3	5.94	CA_Upstream= 0.90 SUM CA= 1.69

Final Area= 4.77 acres

Tt (Kirpich's)	Overland Flow	Tt = (11.9*L <sup>3</sup> /(Hp-Lp)) <sup>0.385</sup>
Tc=Ti+Tt	Figure 3-4	<u>Summary</u>
I (7.44P <sub>6</sub> (Tc) <sup>-.645</sup> ) =	3.19 min	Q Node 1-5= 9.06 cfs
	11.64 min	I= 5.35 in/hr
	5.35 in/hr	Tc= 11.64 min
Q Node 1-5=	9.06 cfs	Sum CA= 1.69
		Area= 4.77 acres

Land Use Element =	n/a	From Table 3-1
Percentage of Basin =	0.00%	C = <u>0.33</u>
Percent Impervious =	6.34%	From Formula Page 3-5
Percentage of Basin =	100.00%	C = <u>0.36</u> Cp = 0.5*0.30+0.5*0.35 = 0.325
Hydrologic Soil Group =	C/D	50/50 split
Coefficient of Runoff =	<u>0.36</u>	Proportionate Average

TM 5401  
Off. Basin 2

Rational Method  
100 Year Storm

1 AREA (A) = 50116.00 sq.ft. = 1.15 ACRES

2 COEFFICIENT OF RUNOFF (C) COEFFICIENT "C"

LAND USE <u>NRCS ELEMENTS</u>	<u>DENSITY</u>	<u>SOIL TYPE</u>	<u>% IMPERV.</u>	
1 DU/A	OPEN	C	0	= 0.36
CA = 0.41				C = 0.36

3 TIME OF CONCENTRATION (TC) - (NATURAL WATERSHED)

HIGH POINT (Hh) = 646 LOW POINT (HI) = 600

H = Hh - HI = 46.00 ft. S = 8.1%

CHANGE IN ELEV. ALONG EFFECTIVE SLOPE LINE = 46.00 ft.

L = 570.00 ft.

Li = 100.00 ft. 0.02 MILES

Lt = 470.00 ft. 0.11 MILES

Ti = 6.65 MIN FROM FIGURE 3-3

Tt = 2.73 MIN FROM FIGURE 3-4

Tc = 9.37 MIN

4 INTENSITY (I) FOR FREQUENCY YEAR 100

SEE ATTACHMENT 1 FOR PRECIPITATION MAPS FROM THE SAN DIEGO COUNTY HYDROLOGY MANUAL

A) P<sub>6</sub> = 3.5 P<sub>24</sub> = 6.0 P<sub>6</sub>/P<sub>24</sub> = 58.3%

B) P<sub>6</sub>(ADJUSTED) = 3.5

C) I = 6.15 IN/HR (I=7.44P<sub>6</sub>(T<sub>c</sub>)<sup>-0.45</sup>)

5 RUNOFF (Q)

Q = CIA = 2.55 cfs Node 2-1 to 2-2 (=1-4)

**Node -1-4 to 1-5*****Ex. Basin 4*****Data**

P <sub>6</sub> =	3.5 in	
P <sub>24</sub> =	6.0 in	
Area_Ex. Basin 4 (acres)	0.09	
Area_Off. Basin 2 (acres)	1.15	Upstream
C_Ex. Basin 4	0.66	See Below
CA_Upstream	0.41	Upstream

**Ex. Basin 4**

High point	600.00	
Low point	593.50	
Distance	194.75	Slope= 0.0334 3.34%

**Off. Basin 2**

Ti (min)	9.37	Upstream
I (in/hr)	6.15	CA_Ex. Basin 4= 0.06
Q Node 2-1	2.55	CA_Upstream= 0.41 SUM CA= 0.47

**Assumptions**

Estimate q_avg (cfs/acre)	2.2	Final Area= 1.24 acres
Qavg	2.64 cfs	

**Determine Velocity**

Velocity	Street Flow - AC Berm
	3.90 fps
Tt	0.83 min
Tc=Ti+Tt	10.20 min
I (7.44P <sub>6</sub> (Tc) <sup>-0.645</sup> ) =	5.82 in/hr
Q_check (must = Est Q_avg)	2.64 cfs
Q Node 1-5=	<b>2.74 cfs</b>

**Summary**

Q Node 1-5=	2.74 cfs
I=	5.82 in/hr
Tc=	10.20 min
Sum CA=	0.47
Area=	1.24 acres

Land Use Element =  
Percentage of Basin =

n/a  
0.00%

From Table 3-1

C = **0.35**

Percent Impervious =  
Percentage of Basin =

59.90%  
100.00%

From Formula Page 3-5

C = **0.66**

Hydrologic Soil Group =

**C**

Coefficient of Runoff =

0.66

Proportionate Average

EB 4 VC.txt

Velocity Check for Existing Basin 4

Qavg = 2.64 cfs, Savg = 3.34%

Street Flow with AC Berm

Channel Calculator

Given Input Data:

Shape .....	Trapezoidal
Solving for .....	Depth of Flow
Flowrate .....	2.6400 cfs
Slope .....	0.0334 ft/ft
Manning's n .....	0.0130
Height .....	6.0000 in
Bottom width .....	0.0000 in
Left slope .....	0.0200 ft/ft (V/H)
Right slope .....	3.0000 ft/ft (V/H)

Computed Results:

Depth .....	1.9670 in
Velocity .....	3.9040 fps
Full Flowrate .....	51.6616 cfs
Flow area .....	0.6762 ft <sup>2</sup>
Flow perimeter .....	100.4455 in
Hydraulic radius .....	0.9694 in
Top width .....	99.0080 in
Area .....	6.2917 ft <sup>2</sup>
Perimeter .....	306.3845 in
Percent full .....	32.7841 %

Critical Information

Critical depth .....	2.7938 in
Critical slope .....	0.0051 ft/ft
Critical velocity .....	1.9353 fps
Critical area .....	1.3641 ft <sup>2</sup>
Critical perimeter .....	142.6636 in
Critical hydraulic radius .....	1.3769 in
Critical top width .....	140.6220 in
Specific energy .....	0.4008 ft
Minimum energy .....	0.3492 ft
Froude number .....	2.4041
Flow condition .....	Supercritical

## **Junction Equation**

### ***Q for Node 1-5 - Existing Conditions***

Arrange from the lowest Tc to highest Tc

T1<T2<T3

System	Q(cfs)	Tc(min)	I(in/hr)	A(acres)	Sum CA
Q Ex. Basin 4	2.74	10.20	5.82	1.24	0.47
Q Ex. Basin 3	9.06	11.64	5.35	4.77	1.69
				6.01	2.16

$$Qt_1 = Q_1 + (T_1/T_2) * Q_2 = 10.68 \text{ cfs}$$

$$Qt_2 = Q_2 + (I_2/I_1) * Q_1 = 11.58 \text{ cfs}$$

Select the largest Q and use the Tc associated with that Q:

If Q's are equal, use the lowest value:

Largest Q=	11.58 cfs
Tc associated=	11.64 min
Area(acres)=	6.01 acres
I(in/hr)=	5.35 in/hr

TM 5401  
Existing Basin 5

Rational Method  
100 Year Storm

1 AREA (A) = 3867.35 sq.ft. = 0.09 ACRES  
2 COEFFICIENT OF RUNOFF (C) COEFFICIENT "C"

LAND USE <u>NRCS ELEMENTS</u>	<u>DENSITY</u>	<u>% BASIN</u>	<u>% IMPERV.</u>		
UNDISTURBED NATURAL	OPEN	100	0	=	0.35
LOW DENSITY RESIDENTIAL	1.0 DU/A	0	10	=	0.41
LOW DENSITY RESIDENTIAL	2.0 DU/A	0	20	=	0.46
LOW DENSITY RESIDENTIAL	2.9 DU/A	0	25	=	0.49
MEDIUM DENSITY RESIDENTIAL	4.3 DU/A	0	30	=	0.52
MEDIUM DENSITY RESIDENTIAL	7.3 DU/A	0	40	=	0.57
MEDIUM DENSITY RESIDENTIAL	10.9 DU/A	0	45	=	0.60
MEDIUM DENSITY RESIDENTIAL	14.5 DU/A	0	50	=	0.63
HIGH DENSITY RESIDENTIAL	24 DU/A	0	65	=	0.71
HIGH DENSITY RESIDENTIAL	43.0 DU/A	0	80	=	0.79
COMMERCIAL/INDUSTRIAL	NEIGH.	0	80	=	0.79
COMMERCIAL/INDUSTRIAL	GEN. COM.	0	85	=	0.82
COMMERCIAL/INDUSTRIAL	OFFICE	0	90	=	0.85
COMMERCIAL/INDUSTRIAL	LIMITED	0	90	=	0.85
COMMERCIAL/INDUSTRIAL	GEN. IND.	0	95	=	0.87
PERCENT IMPERVIOUS		0	100.00	=	0.90
SOIL GROUP	<u>D</u>		CA = <u>0.03</u>	C = <u>0.35</u>	

3 TIME OF CONCENTRATION (TC) - SHEET FLOW

$$\begin{aligned} \text{HIGH POINT (Hh)} &= 745.95 & \text{LOW POINT (Hl)} &= 723.19 \\ H = Hh - Hl &= 22.76 \text{ ft.} & S &= 22.8\% \\ L &= 100.00 \text{ ft.} & \\ L_M &= 100.00 \text{ ft.} & \text{FROM TABLE 3-2.} & & 0.02 \text{ MILES} \\ T_i &= 4.81 \text{ MIN} & & & \end{aligned}$$

4 INTENSITY (I) FOR FREQUENCY YEAR 100

SEE ATTACHMENT 1 FOR PRECIPITATION MAPS FROM THE SAN DIEGO COUNTY HYDROLOGY MANUAL

$$\begin{aligned} A) P_6 &= 3.5 & P_{24} &= 6.0 & P_6/P_{24} &= 58.3\% \\ B) & & P_6(\text{ADJUSTED}) &= 3.5 & & \\ C) I &= 9.22 \text{ IN/HR} \quad (I = 7.44 P_6 (T_C)^{-0.45}) & & & \text{Tc for } I = 5 \text{ minutes per 3.3 Item 2} \end{aligned}$$

5 RUNOFF (Q)

$$Q = CIA = 0.29 \text{ cfs} \quad \text{Node 1-6 to 1-7}$$

**Node -1-7 to 1-8*****Ex. Basin 6*****Data**

P <sub>6</sub> =	3.5 in	
P <sub>24</sub> =	6.0 in	
Area_Ex. Basin 6 (acres)	5.36	
Area_Ex. Basin 5 (acres)	0.09	Upstream
C_Ex. Basin 6	0.34	See Below
CA_Upstream	0.03	Upstream

**Ex. Basin 4**

High point	723.19	
Low point	587.93	
Distance	1177.41	Slope= 0.1149 11.49%

**Ex. Node 1-7**

T <sub>i</sub> (min)	4.81	Upstream
I (in/hr)	9.22	CA_Ex. Basin 6= 1.80
Q Node 1-7	0.29	CA_Upstream= 0.03 SUM CA= 1.83

Final Area= 5.45 acres

T <sub>t</sub> (Kirpich's)	Overland Flow	T <sub>t</sub> = $(11.9 \cdot L^3 / (H_p - L_p))^{0.385}$
T <sub>c</sub> =T <sub>i</sub> +T <sub>t</sub>	Figure 3-4	<u>Summary</u>
I (7.44P <sub>6</sub> (T <sub>c</sub> ) <sup>-0.645</sup> ) =	4.07 min	Q Node 1-8= 11.68 cfs
	8.88 min	I= 6.37 in/hr
	6.37 in/hr	T <sub>c</sub> = 8.88 min
Q Node 1-8=	11.68 cfs	Sum CA= 1.83
		Area= 5.45 acres

Land Use Element =	n/a	From Table 3-1
Percentage of Basin =	0.00%	C = 0.33
Percent Impervious =	1.12%	From Formula Page 3-5
Percentage of Basin =	100.00%	C = 0.34 C <sub>p</sub> = 0.40 * 0.30 + 0.60 * 0.35 = 0.33
Hydrologic Soil Group =	C/D	40/60 Split
Coefficient of Runoff =	0.34	Proportionate Average

TM 5401  
Offsite Basin 1

Rational Method  
100 Year Storm

1 AREA (A) = 11329.00 sq.ft. = 0.26 ACRES  
 2 COEFFICIENT OF RUNOFF (C) COEFFICIENT "C"

LAND USE <u>NRCS ELEMENTS</u>	<u>DENSITY</u>	<u>% BASIN</u>	<u>% IMPERV.</u>	
UNDISTURBED NATURAL	OPEN	0	0	= 0.30
LOW DENSITY RESIDENTIAL	1.0 DU/A	100	10	= 0.36
LOW DENSITY RESIDENTIAL	2.0 DU/A	0	20	= 0.42
LOW DENSITY RESIDENTIAL	2.9 DU/A	0	25	= 0.45
MEDIUM DENSITY RESIDENTIAL	4.3 DU/A	0	30	= 0.48
MEDIUM DENSITY RESIDENTIAL	7.3 DU/A	0	40	= 0.54
MEDIUM DENSITY RESIDENTIAL	10.9 DU/A	0	45	= 0.57
MEDIUM DENSITY RESIDENTIAL	14.5 DU/A	0	50	= 0.60
HIGH DENSITY RESIDENTIAL	24 DU/A	0	65	= 0.69
HIGH DENSITY RESIDENTIAL	43.0 DU/A	0	80	= 0.78
COMMERCIAL/INDUSTRIAL	NEIGH.	0	80	= 0.78
COMMERCIAL/INDUSTRIAL	GEN. COM.	0	85	= 0.81
COMMERCIAL/INDUSTRIAL	OFFICE	0	90	= 0.84
COMMERCIAL/INDUSTRIAL	LIMITED	0	90	= 0.84
COMMERCIAL/INDUSTRIAL	GEN. IND.	0	95	= 0.87
PERCENT IMPERVIOUS		0	100.00	= 0.90
SOIL GROUP	C	CA =	0.09	C = 0.36

3 TIME OF CONCENTRATION (TC) - SHEET FLOW

$$\begin{aligned} \text{HIGH POINT (Hh)} &= 607.89 & \text{LOW POINT (Hl)} &= 593.97 \\ H = Hh - Hl &= 13.92 \text{ ft.} & S &= 6.3\% \\ L &= 219.91 \text{ ft.} \\ L_M &= 100.00 \text{ ft.} & \text{FROM TABLE 3-2.} & & 0.04 \text{ MILES} \\ T_i &= 7.25 \text{ MIN} \end{aligned}$$

4 INTENSITY (I) FOR FREQUENCY YEAR 100

SEE ATTACHMENT 1 FOR PRECIPITATION MAPS FROM THE SAN DIEGO COUNTY HYDROLOGY MANUAL

$$\begin{aligned} A) P_6 &= 3.5 & P_{24} &= 6.0 & P_6/P_{24} &= 58.3\% \\ B) & & P_6(\text{ADJUSTED}) &= 3.5 \\ C) I &= 7.26 \text{ IN/HR } (I = 7.44 P_6 (T_C)^{-0.45}) \end{aligned}$$

5 RUNOFF (Q)

$$Q = CIA = 0.68 \text{ cfs} \quad \text{Node 1-1 to 1-2}$$

**Node -1-5 to 1-8*****Ex. Basin 7*****Data**

P <sub>6</sub> =	3.5 in	
P <sub>24</sub> =	6.0 in	
Area_Ex. Basin 7 (acres)	0.13	
Area_Ex. Node 1-5 (acres)	6.01	Upstream
C_Ex. Basin 7	0.79	See Below
CA_Upstream	2.16	Upstream

**Ex. Basin 7**

High point	593.50	
Low point	584.50	
Distance	278.60	Slope= 0.0323 3.23%

**Ex. Node 1-5**

Ti (min)	11.64	Upstream
I (in/hr)	5.35	CA_Ex. Basin 7= 0.10
Q Node 1-5	11.58	CA_Upstream= 2.16 SUM CA= 2.27

**Assumptions**

Estimate q_avg (cfs/acre)	0.1	Final Area= 6.13 acres
Qavg	11.58 cfs	

**Determine Velocity**

Velocity	Street Flow - AC Berm
	5.58 fps
Tt	0.83 min
Tc=Ti+Tt	12.47 min
I (7.44P <sub>6</sub> (Tc) <sup>-0.645</sup> ) =	5.11 in/hr
Q_check (must = Est Q_avg)	11.58 cfs
Q Node 1-8=	11.59 cfs

**Summary**

Q Node 1-8=	11.59 cfs
I=	5.11 in/hr
Tc=	12.47 min
Sum CA=	2.27
Area=	6.13 acres

Per 3.3, Item 3

Land Use Element =  
Percentage of Basin =

n/a  
0.00%

From Table 3-1

C = 0.35

Percent Impervious =  
Percentage of Basin =

80.91%  
100.00%

From Formula Page 3-5

C = 0.79

Hydrologic Soil Group =

C

Coefficient of Runoff =

0.79

Proportionate Average

EB 7 VC.txt

Velocity Check for Existing Basin 7

Qavg = 11.58 cfs, Savg = 3.23%

Street Flow with AC Berm

Channel Calculator

Given Input Data:

Shape .....	Trapezoidal
Solving for .....	Depth of Flow
Flowrate .....	11.5800 cfs
Slope .....	0.0323 ft/ft
Manning's n .....	0.0130
Height .....	6.0000 in
Bottom width .....	0.0000 in
Left slope .....	0.0200 ft/ft (V/H)
Right slope .....	3.0000 ft/ft (V/H)

Computed Results:

Depth .....	3.4461 in
Velocity .....	5.5793 fps
Full Flowrate .....	50.8038 cfs
Flow area .....	2.0755 ft <sup>2</sup>
Flow perimeter .....	175.9732 in
Hydraulic radius .....	1.6984 in
Top width .....	173.4550 in
Area .....	6.2917 ft <sup>2</sup>
Perimeter .....	306.3845 in
Percent full .....	57.4354 %

Critical Information

Critical depth .....	5.0471 in
Critical slope .....	0.0042 ft/ft
Critical velocity .....	2.6012 fps
Critical area .....	4.4519 ft <sup>2</sup>
Critical perimeter .....	257.7241 in
Critical hydraulic radius .....	2.4874 in
Critical top width .....	254.0359 in
Specific energy .....	0.7709 ft
Minimum energy .....	0.6309 ft
Froude number .....	2.5958
Flow condition .....	Supercritical

Time of Concentration from Off. Basin 1 to Node 1-8 Earthen Swale

$$T_i = 7.25$$

$$L = 152.46 \text{ ft} \quad T_t \text{ per Kirpich's Formula}$$

$$T_t = (11.9 * L^3 / E)^{0.385}$$

$$T_t = 1.09 \text{ min} \quad T_c = 7.25 + 1.09 = 8.34 \text{ min}$$

$$E = 9.47 \text{ ft}$$

### **Junction Equation**

### ***Q for Node 1-8 - Existing Conditions***

Arrange from the lowest  $T_c$  to highest  $T_c$

$T_1 < T_2 < T_3$

System	Q(cfs)	$T_c$ (min)	I(in/hr)	A(acres)	Sum CA
Q Off. Basin 1	0.68	8.34	6.63	0.26	0.09
Q Ex. Basin 6	11.68	8.88	6.37	5.45	1.83
Q Ex. Basin 7	11.59	12.47	5.11	6.13	2.27
				11.84	4.19

$$Qt_1 = Q_1 + (T_1/T_2) * Q_2 + (T_1/T_3) * Q_3 = 19.39 \text{ cfs}$$

$$Qt_2 = Q_2 + (I_2/I_1) * Q_1 + (T_2/T_3) * Q_3 = 20.58 \text{ cfs}$$

$$Qt_3 = Q_3 + (I_3/I_1) * Q_1 + (I_3/I_2) * Q_2 = 21.49 \text{ cfs}$$

Select the largest Q and use the  $T_c$  associated with that Q:

If Q's are equal, use the lowest value:

Largest Q=	21.49 cfs
$T_c$ associated=	12.47 min
Area(acres)=	11.84 acres
I(in/hr)=	5.11 in/hr

TM 5401  
Off. Basin 3

Rational Method  
100 Year Storm

1 AREA (A) = 40835.00 sq.ft. = 0.94 ACRES

2 COEFFICIENT OF RUNOFF (C) COEFFICIENT "C"

LAND USE <u>NRCS ELEMENTS</u>	<u>DENSITY</u>	<u>SOIL TYPE</u>	<u>% IMPERV.</u>	
1 DU/A	OPEN	C	0	= 0.36
CA = 0.34				C = 0.36

3 TIME OF CONCENTRATION (TC) - (NATURAL WATERSHED)

HIGH POINT (Hh) = 749.3 LOW POINT (HI) = 646.7

H = Hh - HI = 102.60 ft. S = 20.4%

CHANGE IN ELEV. ALONG EFFECTIVE SLOPE LINE = 46.00 ft.

L = 503.76 ft.

Li = 100.00 ft. 0.02 MILES

Lt = 403.76 ft. 0.10 MILES

Ti = 4.88 MIN FROM FIGURE 3-3

Tt = 2.36 MIN FROM FIGURE 3-4

Tc = 7.25 MIN

4 INTENSITY (I) FOR FREQUENCY YEAR 100

SEE ATTACHMENT 1 FOR PRECIPITATION MAPS FROM THE SAN DIEGO COUNTY HYDROLOGY MANUAL

A) P<sub>6</sub> = 3.5 P<sub>24</sub> = 6.0 P<sub>6</sub>/P<sub>24</sub> = 58.3%

B) P<sub>6</sub>(ADJUSTED) = 3.5

C) I = 7.26 IN/HR (I=7.44P<sub>6</sub>(T<sub>c</sub>)<sup>-0.645</sup>)

5 RUNOFF (Q)

Q = CIA = 2.45 cfs Node 3-1 to 2-2

## **Proposed Conditions**

TM 5401  
Proposed Basin 1

Rational Method  
100 Year Storm

1 AREA (A) = 2210.99 sq.ft. = 0.05 ACRES  
2 COEFFICIENT OF RUNOFF (C) COEFFICIENT "C"

LAND USE <u>NRCS ELEMENTS</u>	<u>DENSITY</u>	<u>% BASIN</u>	<u>% IMPERV.</u>		
UNDISTURBED NATURAL	OPEN	0	0	=	0.35
LOW DENSITY RESIDENTIAL	1.0 DU/A	0	10	=	0.41
LOW DENSITY RESIDENTIAL	2.0 DU/A	0	20	=	0.46
LOW DENSITY RESIDENTIAL	2.9 DU/A	0	25	=	0.49
MEDIUM DENSITY RESIDENTIAL	4.3 DU/A	0	30	=	0.52
MEDIUM DENSITY RESIDENTIAL	7.3 DU/A	0	40	=	0.57
MEDIUM DENSITY RESIDENTIAL	10.9 DU/A	0	45	=	0.60
MEDIUM DENSITY RESIDENTIAL	14.5 DU/A	0	50	=	0.63
HIGH DENSITY RESIDENTIAL	24 DU/A	0	65	=	0.71
HIGH DENSITY RESIDENTIAL	43.0 DU/A	0	80	=	0.79
COMMERCIAL/INDUSTRIAL	NEIGH.	0	80	=	0.79
COMMERCIAL/INDUSTRIAL	GEN. COM.	0	85	=	0.82
COMMERCIAL/INDUSTRIAL	OFFICE	0	90	=	0.85
COMMERCIAL/INDUSTRIAL	LIMITED	0	90	=	0.85
COMMERCIAL/INDUSTRIAL	GEN. IND.	0	95	=	0.87
PERCENT IMPERVIOUS		100.00	0.00	=	0.35
SOIL GROUP	<b>D</b>		CA = 0.02	C = 0.35	

3 TIME OF CONCENTRATION (TC) - SHEET FLOW

$$\begin{aligned} \text{HIGH POINT (Hh)} &= 787.7 \\ H = Hh - HI &= 14.00 \text{ ft.} \\ L &= 166.63 \text{ ft.} \\ L_M &= 100.00 \text{ ft.} \quad \text{FROM TABLE 3-2.} \\ T_i &= 6.69 \text{ MIN} \end{aligned}$$

$$\begin{aligned} \text{LOW POINT (HI)} &= 773.7 \\ S &= 8.4\% \\ \text{0.03 MILES} \end{aligned}$$

4 INTENSITY (I) FOR FREQUENCY YEAR **100**

SEE ATTACHMENT 1 FOR PRECIPITATION MAPS FROM THE SAN DIEGO COUNTY HYDROLOGY MANUAL

$$\begin{aligned} A) P_6 &= 3.5 & P_{24} &= 6.0 & P_6/P_{24} &= 58.3\% \\ B) & & P_6(\text{ADJUSTED}) &= 3.5 & & \\ C) I &= 7.64 \text{ IN/HR} \quad (I=7.44P_6(T_C)^{-0.45}) \end{aligned}$$

5 RUNOFF (Q)

$$Q = CIA = 0.14 \text{ cfs} \quad \text{Node 1-1 to 1-2}$$

**Node -1-2 to 1-2.1*****Pr. Basin 2*****Data**

P <sub>6</sub> =	3.5 in	
P <sub>24</sub> =	6.0 in	
Area_Pr. Basin 2 (acres)	0.25	
Area_Pr. Node 1-1 (acres)	0.05	Upstream
C_Pr. Basin 2	0.35	See Below
CA_Upstream	0.02	Upstream

**Pr. Basin 2**

High point	773.70	
Low point	751.30	
Distance	109.28	Slope= 0.2050 20.50%

**Pr. Node 1-2**

Ti (min)	6.69	Upstream
I (in/hr)	7.64	CA_Pr. Basin 2= 0.09
Q Node 1-2	0.14	CA_Upstream= 0.02 SUM CA= 0.11

Final Area= 0.30 acres

Tt (Kirpich's)	Overland Flow	Tt = (11.9*L <sup>3</sup> /(Hp-Lp)) <sup>0.385</sup>
Tc=Ti+Tt	Figure 3-4	<u>Summary</u>
I (7.44P <sub>6</sub> (Tc) <sup>-0.645</sup> ) =	0.52 min	Q Node 1-2.1= 0.77 cfs
	7.21 min	I= 7.28 in/hr
	7.28 in/hr	Tc= 7.21 min
Q Node 1-2.1=	0.77 cfs	Sum CA= 0.11
		Area= 0.30 acres

Land Use Element =	n/a	From Table 3-1
Percentage of Basin =	0.00%	C = 0.35
Percent Impervious =	0.00%	From Formula Page 3-5
Percentage of Basin =	100.00%	C = 0.35
Hydrologic Soil Group =	D	
Coefficient of Runoff =	0.35	Proportionate Average

TM 5401  
Proposed Basin 3

Rational Method  
100 Year Storm

1 AREA (A) = 29934.69 sq.ft. = 0.69 ACRES  
2 COEFFICIENT OF RUNOFF (C) COEFFICIENT "C"

LAND USE <u>NRCS ELEMENTS</u>	<u>DENSITY</u>	<u>% BASIN</u>	<u>% IMPERV.</u>	
UNDISTURBED NATURAL	OPEN	0	0	= 0.35
LOW DENSITY RESIDENTIAL	1.0 DU/A	0	10	= 0.41
LOW DENSITY RESIDENTIAL	2.0 DU/A	0	20	= 0.46
LOW DENSITY RESIDENTIAL	2.9 DU/A	56.92	25	= 0.49
MEDIUM DENSITY RESIDENTIAL	4.3 DU/A	0	30	= 0.52
MEDIUM DENSITY RESIDENTIAL	7.3 DU/A	0	40	= 0.57
MEDIUM DENSITY RESIDENTIAL	10.9 DU/A	0	45	= 0.60
MEDIUM DENSITY RESIDENTIAL	14.5 DU/A	0	50	= 0.63
HIGH DENSITY RESIDENTIAL	24 DU/A	0	65	= 0.71
HIGH DENSITY RESIDENTIAL	43.0 DU/A	0	80	= 0.79
COMMERCIAL/INDUSTRIAL	NEIGH.	0	80	= 0.79
COMMERCIAL/INDUSTRIAL	GEN. COM.	0	85	= 0.82
COMMERCIAL/INDUSTRIAL	OFFICE	0	90	= 0.85
COMMERCIAL/INDUSTRIAL	LIMITED	0	90	= 0.85
COMMERCIAL/INDUSTRIAL	GEN. IND.	0	95	= 0.87
PERCENT IMPERVIOUS		43.08	0.00	= 0.35
SOIL GROUP	<b>D</b>		CA = 0.30	C = 0.43

3 TIME OF CONCENTRATION (TC) - SHEET FLOW

$$\begin{aligned} \text{HIGH POINT (Hh)} &= 720 & \text{LOW POINT (Hl)} &= 717.7 \\ H = Hh - Hl &= 2.30 \text{ ft.} & S &= 1.1\% \\ L &= 203.98 \text{ ft.} \\ L_M &= 70.00 \text{ ft.} & \text{FROM TABLE 3-2.} & \\ T_i &= 9.70 \text{ MIN} & & \end{aligned}$$

4 INTENSITY (I) FOR FREQUENCY YEAR **100**

SEE ATTACHMENT 1 FOR PRECIPITATION MAPS FROM THE SAN DIEGO COUNTY HYDROLOGY MANUAL

$$\begin{aligned} A) P_6 &= 3.5 & P_{24} &= 6.0 & P_6/P_{24} &= 58.3\% \\ B) & & P_6(\text{ADJUSTED}) &= 3.5 & \\ C) I &= 6.01 \text{ IN/HR } (I = 7.44 P_6 (T_C)^{-0.45}) \end{aligned}$$

5 RUNOFF (Q)

$$Q = CIA = 1.78 \text{ cfs} \quad \text{Node 1-3 to 1-4}$$

Trave Time from Node 1-2.1 to 1-4       $T_i = 7.21 \text{ min}$       D-75 Type B Brow Ditch  
 $L = 95 \text{ ft} @ 3.05\%$        $V = 2.8 \text{ fps}$        $T_t = 0.56 \text{ min}$        $T_c = 7.21 + 0.56 = 7.77 \text{ min}$   
 $L = 142 \text{ ft} @ 20.91\%$        $V = 4.8 \text{ fps}$        $T_t = 0.49 \text{ min}$        $T_c = 7.77 + 0.49 = 8.26 \text{ min}$

### **Junction Equation**

#### ***Q for Node 1-4 - Proposed Conditions***

Arrange from the lowest  $T_c$  to highest  $T_c$

$T_1 < T_2 < T_3$

System	Q(cfs)	Tc(min)	I(in/hr)	A(acres)	Sum CA
Q Pr. Basin 2	0.77	8.26	6.67	0.30	0.11
Q Pr. Basin 3	1.78	9.70	6.01	0.69	0.30
				0.99	0.40

$$Qt_1 = Q_1 + (T_1/T_2) * Q_2 = 2.29 \text{ cfs}$$

$$Qt_2 = Q_2 + (I_2/I_1) * Q_1 = 2.47 \text{ cfs}$$

Select the largest Q and use the  $T_c$  associated with that Q:

If Q's are equal, use the lowest value:

Largest Q=	2.47 cfs
Tc associated=	9.70 min
Area(acres)=	0.99 acres
I(in/hr)=	6.01 in/hr

Node 1-20 to 1-22 BD1.txt  
Velocity Check for Concrete Brow Ditch from  
Node 1-20 to 1-22  
24" BD @ 5.09%

#### Channel Calculator

##### Given Input Data:

Shape .....	Advanced
Solving for .....	Depth of Flow
Flowrate .....	6.6000 cfs
Slope .....	0.0509 ft/ft
Manning's n .....	0.0150
Height .....	12.0000 in
Bottom width .....	0.0000 in
Left radius .....	12.0000 in
Right radius .....	12.0000 in
Left slope .....	1000.0000 ft/ft (V/H)
Right slope .....	1000.0000 ft/ft (V/H)

##### Computed Results:

Depth .....	7.5390 in
Velocity .....	7.9764 fps
Full Flowrate .....	22.1167 cfs
Flow area .....	0.8274 ft <sup>2</sup>
Flow perimeter .....	46.5731 in
Hydraulic radius .....	2.5584 in
Top width .....	23.9911 in
Area .....	1.5708 ft <sup>2</sup>
Perimeter .....	37.6991 in
Percent full .....	62.8252 %

##### Critical Information

Critical depth .....	10.9378 in
Critical slope .....	0.0073 ft/ft
Critical velocity .....	4.7354 fps
Critical area .....	1.3938 ft <sup>2</sup>
Critical perimeter .....	39.7755 in
Critical hydraulic radius .....	5.0459 in
Critical top width .....	23.9979 in
Specific energy .....	1.6170 ft
Minimum energy .....	1.3672 ft
Froude number .....	2.1859
Flow condition .....	Supercritical

Node 1-2.1 to 1-4 BD2.txt  
Velocity Check for concrete Brow Ditch from  
Node 1-2.1 to 1-4  
24" BD @ 20.90%

### Channel Calculator

#### Given Input Data:

Shape .....	Advanced
Solving for .....	Depth of Flow
Flowrate .....	0.7700 cfs
Slope .....	0.2090 ft/ft
Manning's n .....	0.0150
Height .....	12.0000 in
Bottom width .....	0.0000 in
Left radius .....	12.0000 in
Right radius .....	12.0000 in
Left slope .....	1000.0000 ft/ft (V/H)
Right slope .....	1000.0000 ft/ft (V/H)

#### Computed Results:

Depth .....	3.5264 in
Velocity .....	4.8417 fps
Full Flowrate .....	44.8161 cfs
Flow area .....	0.1590 ft <sup>2</sup>
Flow perimeter .....	54.5982 in
Hydraulic radius .....	0.4194 in
Top width .....	23.9831 in
Area .....	1.5708 ft <sup>2</sup>
Perimeter .....	37.6991 in
Percent full .....	29.3870 %

#### Critical Information

Critical depth .....	4.5692 in
Critical slope .....	0.0169 ft/ft
Critical velocity .....	2.3143 fps
Critical area .....	0.3327 ft <sup>2</sup>
Critical perimeter .....	52.5126 in
Critical hydraulic radius .....	0.9124 in
Critical top width .....	23.9852 in
Specific energy .....	0.6582 ft
Minimum energy .....	0.5712 ft
Froude number .....	3.0259
Flow condition .....	Supercritical

**Node -1-4 to 1-4.1*****Pr. Basin 4*****Data**

P <sub>6</sub> =	3.5 in	
P <sub>24</sub> =	6.0 in	
Area_Pr. Basin 4 (acres)	0.84	
Area_Pr. Node 1-4 (acres)	0.99	Upstream
C_Pr. Basin 4	0.35	See Below
CA_Upstream	0.40	Upstream

**Pr. Basin 4**

High point	717.70	
Low point	668.13	
Distance	202.67	Slope= 0.2446 24.46%

**Pr. Node 1-4**

Ti (min)	9.70	Upstream
I (in/hr)	6.01	CA_Pr. Basin 4= 0.29
Q Node 1-4	2.47	CA_Upstream= 0.40 SUM CA= 0.69

Final Area= 1.83 acres

Tt (Kirpich's)	Overland Flow	Tt = $(11.9 \cdot L^3 / (H_p - L_p))^{0.385}$
Tc=Ti+Tt	Figure 3-4	<u>Summary</u>
I (7.44P <sub>6</sub> (Tc) <sup>-0.645</sup> ) =	0.78 min	Q Node 1-4.1= 3.97 cfs
	10.49 min	I= 5.72 in/hr
	5.72 in/hr	Tc= 10.49 min
Q Node 1-4.1=	3.97 cfs	Sum CA= 0.69
		Area= 1.83 acres

Land Use Element =	n/a	From Table 3-1
Percentage of Basin =	0.00%	C = 0.35
Percent Impervious =	0.00%	From Formula Page 3-5
Percentage of Basin =	100.00%	C = 0.35
Hydrologic Soil Group =	D	
Coefficient of Runoff =	0.35	Proportionate Average

**TM 5401  
Proposed Basin 5**

**Rational Method  
100 Year Storm**

1 AREA (A) = 33690.04 sq.ft. = 0.77 ACRES  
 2 COEFFICIENT OF RUNOFF (C) COEFFICIENT "C"

LAND USE <u>NRCS ELEMENTS</u>	DENSITY	% BASIN	% IMPERV.	=	
UNDISTURBED NATURAL	OPEN	0	0	=	0.35
LOW DENSITY RESIDENTIAL	1.0 DU/A	0	10	=	0.41
LOW DENSITY RESIDENTIAL	2.0 DU/A	0	20	=	0.46
LOW DENSITY RESIDENTIAL	2.9 DU/A	51.16	25	=	0.49
MEDIUM DENSITY RESIDENTIAL	4.3 DU/A	0	30	=	0.52
MEDIUM DENSITY RESIDENTIAL	7.3 DU/A	0	40	=	0.57
MEDIUM DENSITY RESIDENTIAL	10.9 DU/A	0	45	=	0.60
MEDIUM DENSITY RESIDENTIAL	14.5 DU/A	0	50	=	0.63
HIGH DENSITY RESIDENTIAL	24 DU/A	0	65	=	0.71
HIGH DENSITY RESIDENTIAL	43.0 DU/A	0	80	=	0.79
COMMERCIAL/INDUSTRIAL	NEIGH.	0	80	=	0.79
COMMERCIAL/INDUSTRIAL	GEN. COM.	0	85	=	0.82
COMMERCIAL/INDUSTRIAL	OFFICE	0	90	=	0.85
COMMERCIAL/INDUSTRIAL	LIMITED	0	90	=	0.85
COMMERCIAL/INDUSTRIAL	GEN. IND.	0	95	=	0.87
PERCENT IMPERVIOUS		48.84	0.00	=	0.35
SOIL GROUP	D		CA = 0.33	C = 0.42	

**3 TIME OF CONCENTRATION (TC) - SHEET FLOW**

$$\begin{aligned} \text{HIGH POINT (Hh)} &= 640 & \text{LOW POINT (Hl)} &= 637.6 \\ H = Hh - Hl &= 2.40 \text{ ft.} & S &= 1.0\% \\ L &= 232.00 \text{ ft.} \\ L_M &= 70.00 \text{ ft.} & \text{FROM TABLE 3-2.} & & 0.04 \text{ MILES} \\ T_i &= 10.10 \text{ MIN} \end{aligned}$$

**4 INTENSITY (I) FOR FREQUENCY YEAR** 100

SEE ATTACHMENT 1 FOR PRECIPITATION MAPS FROM THE SAN DIEGO COUNTY HYDROLOGY MANUAL

$$\begin{aligned} A) P_6 &= 3.5 & P_{24} &= 6.0 & P_6/P_{24} &= 58.3\% \\ B) & & P_6(\text{ADJUSTED}) &= 3.5 & & \\ C) I &= 5.86 \text{ IN/HR } (I = 7.44 P_6 (T_C)^{-0.45}) \end{aligned}$$

**5 RUNOFF (Q)**

$$Q = CIA = 1.91 \text{ cfs} \quad \text{Node 1-5 to 1-6}$$

Trave Time from Node 1-4.1 to 1-6               $T_i = 10.49 \text{ min}$  D-75 Type B Brow Ditch  
 $L = 101 \text{ ft} @ 8.35\%$                $V = 7.3 \text{ fps}$        $T_t = 0.23 \text{ min}$        $T_c = 10.49 + 0.23 = 10.72 \text{ min}$   
 $L = 132 \text{ ft} @ 18.41\%$                $V = 9.2 \text{ fps}$        $T_t = 0.24 \text{ min}$        $T_c = 10.72 + 0.24 = 10.96 \text{ min}$

### **Junction Equation**

#### ***Q for Node 1-6 - Proposed Conditions***

Arrange from the lowest  $T_c$  to highest  $T_c$

$T_1 < T_2 < T_3$

System	Q(cfs)	Tc(min)	I(in/hr)	A(acres)	Sum CA
Q Pr. Basin 5	1.91	10.10	5.86	0.77	0.33
Q Pr. Basin 4	3.97	10.96	5.56	1.83	0.69
				2.60	1.02

$$Q_{t1} = Q_1 + (T_1/T_2) * Q_2 = 5.57 \text{ cfs}$$

$$Q_{t2} = Q_2 + (I_2/I_1) * Q_1 = 5.78 \text{ cfs}$$

Select the largest Q and use the  $T_c$  associated with that Q:

If Q's are equal, use the lowest value:

Largest Q=	5.78 cfs
Tc associated=	10.96 min
Area(acres)=	2.60 acres
I(in/hr)=	5.56 in/hr

Node 1-4.1 to 1-6 BD1.txt  
Velocity Check for Concrete Brow Ditch from  
Node 1-4.1 to 1-6  
24" BD @ 8.34%

Channel Calculator

Given Input Data:

Shape .....	Advanced
Solving for .....	Depth of Flow
Flowrate .....	3.9700 cfs
Slope .....	0.0834 ft/ft
Manning's n .....	0.0150
Height .....	12.0000 in
Bottom width .....	0.0000 in
Left radius .....	12.0000 in
Right radius .....	12.0000 in
Left slope .....	1000.0000 ft/ft (V/H)
Right slope .....	1000.0000 ft/ft (V/H)

Computed Results:

Depth .....	5.8205 in
Velocity .....	7.3362 fps
Full Flowrate .....	28.3103 cfs
Flow area .....	0.5412 ft <sup>2</sup>
Flow perimeter .....	50.0100 in
Hydraulic radius .....	1.5582 in
Top width .....	23.9877 in
Area .....	1.5708 ft <sup>2</sup>
Perimeter .....	37.6991 in
Percent full .....	48.5045 %

Critical Information

Critical depth .....	8.5333 in
Critical slope .....	0.0095 ft/ft
Critical velocity .....	3.9976 fps
Critical area .....	0.9931 ft <sup>2</sup>
Critical perimeter .....	44.5845 in
Critical hydraulic radius .....	3.2075 in
Critical top width .....	23.9931 in
Specific energy .....	1.3214 ft
Minimum energy .....	1.0667 ft
Froude number .....	2.4858
Flow condition .....	Supercritical

Node 1-4.1 to 1-6 BD2.txt  
Velocity Check for Concrete Brow Ditch from  
Node 1-4.1 to 1-6  
24" BD @ 18.40%

Channel Calculator

Given Input Data:

Shape .....	Advanced
Solving for .....	Depth of Flow
Flowrate .....	3.9700 cfs
Slope .....	0.1840 ft/ft
Manning's n .....	0.0150
Height .....	12.0000 in
Bottom width .....	0.0000 in
Left radius .....	12.0000 in
Right radius .....	12.0000 in
Left slope .....	1000.0000 ft/ft (V/H)
Right slope .....	1000.0000 ft/ft (V/H)

Computed Results:

Depth .....	5.1609 in
Velocity .....	9.2054 fps
Full Flowrate .....	42.0504 cfs
Flow area .....	0.4313 ft <sup>2</sup>
Flow perimeter .....	51.3294 in
Hydraulic radius .....	1.2099 in
Top width .....	23.9863 in
Area .....	1.5708 ft <sup>2</sup>
Perimeter .....	37.6991 in
Percent full .....	43.0073 %

Critical Information

Critical depth .....	8.5333 in
Critical slope .....	0.0095 ft/ft
Critical velocity .....	3.9976 fps
Critical area .....	0.9931 ft <sup>2</sup>
Critical perimeter .....	44.5845 in
Critical hydraulic radius .....	3.2075 in
Critical top width .....	23.9931 in
Specific energy .....	1.7470 ft
Minimum energy .....	1.0667 ft
Froude number .....	3.4939
Flow condition .....	Supercritical

**Node -1-6 to 1-6.1*****Pr. Basin 6*****Data**

P <sub>6</sub> =	3.5 in
P <sub>24</sub> =	6.0 in
Area_Pr. Basin 6 (acres)	0.82
Area_Pr. Node 1-6 (acres)	2.60
C_Pr. Basin 6	0.35
CA_Upstream	1.02

**Pr. Basin 6**

High point	635.40		
Low point	610.39		
Distance	212.23	Slope=	0.1178      11.78%

**Pr. Node 1-6**

Ti (min)	10.96	Upstream
I (in/hr)	5.56	CA_Pr. Basin 6= 0.29
Q Node 1-6	5.78	CA_Upstream= 1.02 SUM CA= 1.31

Final Area= 3.42 acres

Tt (Kirpich's)	Overland Flow	Tt = $(11.9 \cdot L^3 / (H_p - L_p))^{0.385}$
Tc=Ti+Tt	Figure 3-4	<u>Summary</u>
I (7.44P <sub>6</sub> (Tc) <sup>-0.645</sup> ) =	1.08 min	Q Node 1-6.1= 6.85 cfs
	12.04 min	I= 5.23 in/hr
	5.23 in/hr	Tc= 12.04 min
Q Node 1-6.1=	6.85 cfs	Sum CA= 1.31
		Area= 3.42 acres

Land Use Element =	n/a	From Table 3-1
Percentage of Basin =	0.00%	C = <u>0.35</u>
Percent Impervious =	0.00%	From Formula Page 3-5
Percentage of Basin =	100.00%	C = <u>0.35</u>
Hydrologic Soil Group =	D	
Coefficient of Runoff =	<u>0.35</u>	Proportionate Average

TM 5401  
Proposed Basin 7

Rational Method  
100 Year Storm

1 AREA (A) = 19188.00 sq.ft. = 0.44 ACRES  
2 COEFFICIENT OF RUNOFF (C) COEFFICIENT "C"

LAND USE <u>NRCS ELEMENTS</u>	<u>DENSITY</u>	<u>% BASIN</u>	<u>% IMPERV.</u>	
UNDISTURBED NATURAL	OPEN	0	0	= 0.30
LOW DENSITY RESIDENTIAL	1.0 DU/A	0	10	= 0.36
LOW DENSITY RESIDENTIAL	2.0 DU/A	0	20	= 0.42
LOW DENSITY RESIDENTIAL	2.9 DU/A	88.49	25	= 0.45
MEDIUM DENSITY RESIDENTIAL	4.3 DU/A	0	30	= 0.48
MEDIUM DENSITY RESIDENTIAL	7.3 DU/A	0	40	= 0.54
MEDIUM DENSITY RESIDENTIAL	10.9 DU/A	0	45	= 0.57
MEDIUM DENSITY RESIDENTIAL	14.5 DU/A	0	50	= 0.60
HIGH DENSITY RESIDENTIAL	24 DU/A	0	65	= 0.69
HIGH DENSITY RESIDENTIAL	43.0 DU/A	0	80	= 0.78
COMMERCIAL/INDUSTRIAL	NEIGH.	0	80	= 0.78
COMMERCIAL/INDUSTRIAL	GEN. COM.	0	85	= 0.81
COMMERCIAL/INDUSTRIAL	OFFICE	0	90	= 0.84
COMMERCIAL/INDUSTRIAL	LIMITED	0	90	= 0.84
COMMERCIAL/INDUSTRIAL	GEN. IND.	0	95	= 0.87
PERCENT IMPERVIOUS		11.05	0.00	= 0.30
SOIL GROUP	C		CA = 0.19	C = 0.43

3 TIME OF CONCENTRATION (TC) - SHEET FLOW

$$\begin{aligned} \text{HIGH POINT (Hh)} &= 612 & \text{LOW POINT (Hl)} &= 609.6 \\ H = Hh - Hl &= 2.40 \text{ ft.} & S &= 1.0\% \\ L &= 239.00 \text{ ft.} \\ L_M &= 70.00 \text{ ft.} & \text{FROM TABLE 3-2.} & & 0.05 \text{ MILES} \\ T_i &= 10.06 \text{ MIN} \end{aligned}$$

4 INTENSITY (I) FOR FREQUENCY YEAR 100

SEE ATTACHMENT 1 FOR PRECIPITATION MAPS FROM THE SAN DIEGO COUNTY HYDROLOGY MANUAL

$$\begin{aligned} A) P_6 &= 3.5 & P_{24} &= 6.0 & P_6/P_{24} &= 58.3\% \\ B) & & P_6(\text{ADJUSTED}) &= 3.5 \\ C) I &= 5.88 \text{ IN/HR } (I = 7.44 P_6 (T_C)^{-0.45}) \end{aligned}$$

5 RUNOFF (Q)

$$Q = CIA = 1.12 \text{ cfs} \quad \text{Node 1-7 to 1-8}$$

## **Junction Equation**

### ***Q for Node 1-8 - Proposed Conditions***

Arrange from the lowest Tc to highest Tc

**T1<T2<T3**

System	Q(cfs)	Tc(min)	I(in/hr)	A(acres)	Sum CA
Q Pr. Basin 7	1.12	10.06	5.88	0.44	0.19
Q Pr. Basin 6	6.85	12.04	5.23	3.42	1.31
				3.86	1.50

$$Qt_1 = Q_1 + (T_1/T_2) * Q_2 = 6.84 \text{ cfs}$$

$$Qt_2 = Q_2 + (I_2/I_1) * Q_1 = 7.84 \text{ cfs}$$

Select the largest Q and use the Tc associated with that Q:

If Q's are equal, use the lowest value:

Largest Q=	7.84 cfs
Tc associated=	12.04 min
Area(acres)=	3.86 acres
I(in/hr)=	5.23 in/hr

**Node -1-8 to 1-10*****Pr. Basin 8*****Data**

P <sub>6</sub> =	3.5 in	
P <sub>24</sub> =	6.0 in	
Area_Pr. Basin 8 (acres)	0.55	
Area_Pr. Node 1-8 (acres)	3.86	Upstream
C_Pr. Basin 8	0.35	See Below
CA_Upstream	1.50	Upstream

**Pr. Basin 8**

High point	609.39	
Low point	594.60	
Distance	224.00	Slope= 0.0660 6.60%

**Pr. Node 1-8**

T <sub>i</sub> (min)	12.04	Upstream
I (in/hr)	5.23	CA_Pr. Basin 8= 0.19
Q Node 1-8	7.84	CA_Upstream= 1.50 SUM CA= 1.69

Final Area= 4.41 acres

T <sub>t</sub> (Kirpich's)	Overland Flow	T <sub>t</sub> = $(11.9 \cdot L^3 / (H_p - L_p))^{0.385}$
T <sub>c</sub> =T <sub>i</sub> +T <sub>t</sub>	Figure 3-4	<u>Summary</u>
I (7.44P <sub>6</sub> (T <sub>c</sub> ) <sup>-0.645</sup> ) =	1.40 min	Q Node 1-10= 8.24 cfs
	13.44 min	I= 4.87 in/hr
	4.87 in/hr	T <sub>c</sub> = 13.44 min
Q Node 1-10=	8.24 cfs	Sum CA= 1.69
		Area= 4.41 acres

Land Use Element =	n/a	From Table 3-1
Percentage of Basin =	0.00%	C = <u>0.35</u>
Percent Impervious =	0.00%	From Formula Page 3-5
Percentage of Basin =	100.00%	C = <u>0.35</u>
Hydrologic Soil Group =	D	
Coefficient of Runoff =	<u>0.35</u>	Proportionate Average

TM 5401  
Proposed Basin 9

Rational Method  
100 Year Storm

1 AREA (A) = 9677.74 sq.ft. = 0.22 ACRES  
2 COEFFICIENT OF RUNOFF (C) COEFFICIENT "C"

LAND USE <u>NRCS ELEMENTS</u>	<u>DENSITY</u>	<u>% BASIN</u>	<u>% IMPERV.</u>	
UNDISTURBED NATURAL	OPEN	0	0	= 0.30
LOW DENSITY RESIDENTIAL	1.0 DU/A	0	10	= 0.36
LOW DENSITY RESIDENTIAL	2.0 DU/A	0	20	= 0.42
LOW DENSITY RESIDENTIAL	2.9 DU/A	0	25	= 0.45
MEDIUM DENSITY RESIDENTIAL	4.3 DU/A	0	30	= 0.48
MEDIUM DENSITY RESIDENTIAL	7.3 DU/A	100	40	= 0.54
MEDIUM DENSITY RESIDENTIAL	10.9 DU/A	0	45	= 0.57
MEDIUM DENSITY RESIDENTIAL	14.5 DU/A	0	50	= 0.60
HIGH DENSITY RESIDENTIAL	24 DU/A	0	65	= 0.69
HIGH DENSITY RESIDENTIAL	43.0 DU/A	0	80	= 0.78
COMMERCIAL/INDUSTRIAL	NEIGH.	0	80	= 0.78
COMMERCIAL/INDUSTRIAL	GEN. COM.	0	85	= 0.81
COMMERCIAL/INDUSTRIAL	OFFICE	0	90	= 0.84
COMMERCIAL/INDUSTRIAL	LIMITED	0	90	= 0.84
COMMERCIAL/INDUSTRIAL	GEN. IND.	0	95	= 0.87
PERCENT IMPERVIOUS		0	0.00	= 0.30
SOIL GROUP	C	CA =	0.12	C = 0.54

3 TIME OF CONCENTRATION (TC) - SHEET FLOW

$$\begin{aligned} \text{HIGH POINT (Hh)} &= 610 & \text{LOW POINT (Hl)} &= 608.3 \\ H = Hh - Hl &= 1.70 \text{ ft.} & S &= 1.0\% \\ L &= 170.36 \text{ ft.} \\ L_M &= 50.00 \text{ ft.} & \text{FROM TABLE 3-2.} & \\ T_i &= 7.13 \text{ MIN} & & \end{aligned}$$

4 INTENSITY (I) FOR FREQUENCY YEAR 100

SEE ATTACHMENT 1 FOR PRECIPITATION MAPS FROM THE SAN DIEGO COUNTY HYDROLOGY MANUAL

$$\begin{aligned} A) P_6 &= 3.5 & P_{24} &= 6.0 & P_6/P_{24} &= 58.3\% \\ B) & & P_6(\text{ADJUSTED}) &= 3.5 & \\ C) I &= 7.33 \text{ IN/HR } (I = 7.44 P_6 (T_C)^{-0.45}) \end{aligned}$$

5 RUNOFF (Q)

$$Q = CIA = 0.88 \text{ cfs} \quad \text{Node 1-9 to 1-9.1}$$

## **Junction Equation**

### ***Q for Node 1-10 - Proposed Conditions***

Arrange from the lowest Tc to highest Tc

**T1<T2<T3**

System	Q(cfs)	Tc(min)	I(in/hr)	A(acres)	Sum CA
Q Pr. Basin 9	0.88	7.13	7.33	0.22	0.12
Q Pr. Basin 8	8.24	13.44	4.87	4.41	1.69
				4.64	1.81

$$Qt_1 = Q_1 + (T_1/T_2) * Q_2 = 5.25 \text{ cfs}$$

$$Qt_2 = Q_2 + (I_2/I_1) * Q_1 = 8.82 \text{ cfs}$$

Select the largest Q and use the Tc associated with that Q:

If Q's are equal, use the lowest value:

Largest Q=	8.82 cfs
Tc associated=	13.44 min
Area(acres)=	4.64 acres
I(in/hr)=	4.87 in/hr

Trave Time from Node 1-10 to 1-10.1       $T_i = 13.44 \text{ min}$  D-75 Type B Brow Ditch  
 $L = 52 \text{ ft} @ 4.42\%$        $V = 10.5 \text{ fps}$        $T_t = 0.08 \text{ min}$        $T_c = 13.44 + 0.08 = 13.52 \text{ min}$

### **Junction Equation**

#### ***Q for Node 1-10.1 - Proposed Conditions***

Arrange from the lowest  $T_c$  to highest  $T_c$

$T_1 < T_2 < T_3$

System	Q(cfs)	Tc(min)	I(in/hr)	A(acres)	Sum CA
Q Offsite Basin 1	0.68	7.25	7.26	0.26	0.09
Q Pr. Node 1-10	8.82	13.52	4.85	4.64	1.81
				4.90	1.90

$$Q_{t1} = Q_1 + (T_1/T_2) * Q_2 = 5.41 \text{ cfs}$$

$$Q_{t2} = Q_2 + (I_2/I_1) * Q_1 = 9.28 \text{ cfs}$$

Select the largest Q and use the  $T_c$  associated with that Q:

If Q's are equal, use the lowest value:

Largest Q=	9.28 cfs
Tc associated=	13.52 min
Area(acres)=	4.90 acres
I(in/hr)=	4.85 in/hr

Node 1-10 to 1-10.1 BD1.txt  
Velocity Check for Concrete Brow Ditch from  
Node 1-10 to 1-10.1  
24" BD @ 4.42%

Manning Pipe Calculator

Given Input Data:

Shape .....	Circular
Solving for .....	Depth of Flow
Diameter .....	24.0000 in
Flowrate .....	8.9500 cfs
Slope .....	0.0442 ft/ft
Manning's n .....	0.0150

Computed Results:

Depth .....	7.5961 in
Area .....	3.1416 ft <sup>2</sup>
Wetted Area .....	0.8536 ft <sup>2</sup>
Wetted Perimeter .....	28.6805 in
Perimeter .....	75.3982 in
Velocity .....	10.4846 fps
Hydraulic Radius .....	4.2860 in
Percent Full .....	31.6504 %
Full flow Flowrate .....	41.2194 cfs
Full flow velocity .....	13.1205 fps

Critical Information

Critical depth .....	12.8209 in
Critical slope .....	0.0067 ft/ft
Critical velocity .....	5.2412 fps
Critical area .....	1.7076 ft <sup>2</sup>
Critical perimeter .....	39.3410 in
Critical hydraulic radius .....	6.2504 in
Critical top width .....	24.0000 in
Specific energy .....	2.3413 ft
Minimum energy .....	1.6026 ft
Froude number .....	2.7288
Flow condition .....	Supercritical

**Node -1-10.1 to 1-24*****Pr. Basin 10*****Data**

P <sub>6</sub> =	3.5 in	
P <sub>24</sub> =	6.0 in	
Area_Pr. Basin 10 (acres)	0.15	
Area_Pr. Node 1-10.1 (acres)	4.90	Upstream
C_Pr. Basin 10	0.35	See Below
CA_Upstream	1.90	Upstream

**Pr. Basin 10**

High point	592.30	
Low point	588.35	
Distance	120.45	Slope= 0.0328 3.28%

**Pr. Node 1-10.1**

T <sub>i</sub> (min)	13.52	Upstream
I (in/hr)	4.85	CA_Pr. Basin 10= 0.05
Q Node 1-10.1	9.28	CA_Upstream= 1.90 SUM CA= 1.96

Final Area= 5.05 acres

T <sub>t</sub> (Kirpich's)	Overland Flow	T <sub>t</sub> = $(11.9 \cdot L^3 / (H_p - L_p))^{0.385}$
T <sub>c</sub> =T <sub>i</sub> +T <sub>t</sub>	Figure 3-4	<u>Summary</u>
I (7.44P <sub>6</sub> (T <sub>c</sub> ) <sup>-0.645</sup> ) =	1.14 min	Q Node 1-24= 9.28 cfs
	14.66 min	I= 4.61 in/hr
	4.61 in/hr	T <sub>c</sub> = 14.66 min
Q Node 1-24=	9.28 cfs	Sum CA= 1.96
		Area= 5.05 acres

Land Use Element =	n/a	From Table 3-1
Percentage of Basin =	0.00%	C = <u>0.35</u>
Percent Impervious =	0.00%	From Formula Page 3-5
Percentage of Basin =	100.00%	C = <u>0.35</u>
Hydrologic Soil Group =	D	
Coefficient of Runoff =	<u>0.35</u>	Proportionate Average

TM 5401  
Proposed Basin 10-A

Rational Method  
100 Year Storm

1 AREA (A) = 15939.68 sq.ft. = 0.37 ACRES  
2 COEFFICIENT OF RUNOFF (C) COEFFICIENT "C"

LAND USE <u>NRCS ELEMENTS</u>	<u>DENSITY</u>	<u>% BASIN</u>	<u>% IMPERV.</u>		
UNDISTURBED NATURAL	OPEN	0	0	=	0.35
LOW DENSITY RESIDENTIAL	1.0 DU/A	0	10	=	0.41
LOW DENSITY RESIDENTIAL	2.0 DU/A	0	20	=	0.46
LOW DENSITY RESIDENTIAL	2.9 DU/A	0	25	=	0.49
MEDIUM DENSITY RESIDENTIAL	4.3 DU/A	0	30	=	0.52
MEDIUM DENSITY RESIDENTIAL	7.3 DU/A	0	40	=	0.57
MEDIUM DENSITY RESIDENTIAL	10.9 DU/A	0	45	=	0.60
MEDIUM DENSITY RESIDENTIAL	14.5 DU/A	0	50	=	0.63
HIGH DENSITY RESIDENTIAL	24 DU/A	0	65	=	0.71
HIGH DENSITY RESIDENTIAL	43.0 DU/A	0	80	=	0.79
COMMERCIAL/INDUSTRIAL	NEIGH.	0	80	=	0.79
COMMERCIAL/INDUSTRIAL	GEN. COM.	0	85	=	0.82
COMMERCIAL/INDUSTRIAL	OFFICE	0	90	=	0.85
COMMERCIAL/INDUSTRIAL	LIMITED	0	90	=	0.85
COMMERCIAL/INDUSTRIAL	GEN. IND.	0	95	=	0.87
PERCENT IMPERVIOUS		100.00	0.00	=	0.35
SOIL GROUP	<b>D</b>		CA = 0.13	C = 0.35	

3 TIME OF CONCENTRATION (TC) - SHEET FLOW

$$\begin{aligned} \text{HIGH POINT (Hh)} &= 592.2 \\ H = Hh - HI &= 7.78 \text{ ft.} \\ L &= 221.00 \text{ ft.} \\ L_M &= 100.00 \text{ ft.} \quad \text{FROM TABLE 3-2.} \\ T_i &= 8.91 \text{ MIN} \end{aligned}$$

$$\begin{aligned} \text{LOW POINT (HI)} &= 584.42 \\ S &= 3.5\% \\ & \quad \quad \quad 0.04 \text{ MILES} \end{aligned}$$

4 INTENSITY (I) FOR FREQUENCY YEAR **100**

SEE ATTACHMENT 1 FOR PRECIPITATION MAPS FROM THE SAN DIEGO COUNTY HYDROLOGY MANUAL

$$\begin{aligned} A) P_6 &= 3.5 & P_{24} &= 6.0 & P_6/P_{24} &= 58.3\% \\ B) & & P_6(\text{ADJUSTED}) &= 3.5 & & \\ C) I &= 6.35 \text{ IN/HR} \quad (I=7.44P_6(T_C)^{-0.45}) \end{aligned}$$

5 RUNOFF (Q)

$$Q = CIA = 0.81 \text{ cfs} \quad \text{Node 1-10-A to 1-24}$$

TM 5401  
Proposed Basin 11

Rational Method  
100 Year Storm

1 AREA (A) = 8629.32 sq.ft. = 0.20 ACRES  
2 COEFFICIENT OF RUNOFF (C) COEFFICIENT "C"

LAND USE <u>NRCS ELEMENTS</u>	<u>DENSITY</u>	<u>% BASIN</u>	<u>% IMPERV.</u>	
UNDISTURBED NATURAL	OPEN	0	0	= 0.35
LOW DENSITY RESIDENTIAL	1.0 DU/A	0	10	= 0.41
LOW DENSITY RESIDENTIAL	2.0 DU/A	0	20	= 0.46
LOW DENSITY RESIDENTIAL	2.9 DU/A	0	25	= 0.49
MEDIUM DENSITY RESIDENTIAL	4.3 DU/A	0	30	= 0.52
MEDIUM DENSITY RESIDENTIAL	7.3 DU/A	0	40	= 0.57
MEDIUM DENSITY RESIDENTIAL	10.9 DU/A	0	45	= 0.60
MEDIUM DENSITY RESIDENTIAL	14.5 DU/A	0	50	= 0.63
HIGH DENSITY RESIDENTIAL	24 DU/A	0	65	= 0.71
HIGH DENSITY RESIDENTIAL	43.0 DU/A	0	80	= 0.79
COMMERCIAL/INDUSTRIAL	NEIGH.	0	80	= 0.79
COMMERCIAL/INDUSTRIAL	GEN. COM.	0	85	= 0.82
COMMERCIAL/INDUSTRIAL	OFFICE	0	90	= 0.85
COMMERCIAL/INDUSTRIAL	LIMITED	0	90	= 0.85
COMMERCIAL/INDUSTRIAL	GEN. IND.	0	95	= 0.87
PERCENT IMPERVIOUS		100.00	64.06	= 0.70
SOIL GROUP	<b>D</b>		CA = 0.14	C = 0.70

3 TIME OF CONCENTRATION (TC) - SHEET FLOW

$$\begin{aligned} \text{HIGH POINT (Hh)} &= 753.87 & \text{LOW POINT (Hl)} &= 747.48 \\ H = Hh - Hl &= 6.39 \text{ ft.} & S &= 6.4\% \\ L &= 100.00 \text{ ft.} & \\ L_M &= 100.00 \text{ ft.} & \text{FROM TABLE 3-2.} & & 0.02 \text{ MILES} \\ T_i &= 5.00 \text{ MIN} & & & \end{aligned}$$

4 INTENSITY (I) FOR FREQUENCY YEAR **100**

SEE ATTACHMENT 1 FOR PRECIPITATION MAPS FROM THE SAN DIEGO COUNTY HYDROLOGY MANUAL

$$\begin{aligned} A) P_6 &= 3.5 & P_{24} &= 6.0 & P_6/P_{24} &= 58.3\% \\ B) & & P_6(\text{ADJUSTED}) &= 3.5 & & \\ C) I &= 9.22 \text{ IN/HR } (I = 7.44 P_6 (T_C)^{-0.45}) & & & & \end{aligned}$$

5 RUNOFF (Q)

$$Q = CIA = 1.28 \text{ cfs} \quad \text{Node 1-11 to 1-12}$$

**Node -1-12 to 1-22/23*****Pr. Basin 12*****Data**

P <sub>6</sub> =	3.5 in	
P <sub>24</sub> =	6.0 in	
Area_Pr. Basin 12 (acres)	0.91	
Area_Pr. Node 1-12 (acres)	0.20	Upstream
C_Pr. Basin 12	0.73	See Below
CA_Upstream	0.14	Upstream

**Pr. Basin 12**

High point	747.48	
Low point	595.20	
Distance	1080.00	Slope= 0.1410      14.10%

**Pr. Node 1-12**

Ti (min)	5.00	Upstream
I (in/hr)	9.22	CA_Pr. Basin 12= 0.67
Q Node 1-12	1.28	CA_Upstream= 0.14 SUM CA= 0.80

**Assumptions**

Estimate q_avg (cfs/acre)	4.43	Final Area= 1.11 acres
Qavg	3.30 cfs	

**Determine Velocity**

Velocity	Gutter Flow 5.35 fps	
Tt	3.36 min	Summary
Tc=Ti+Tt	8.36 min	Q Node 1-22/23= 5.32 cfs
I (7.44P <sub>6</sub> (Tc) <sup>-0.645</sup> ) =	6.62 in/hr	I= 6.62 in/hr
Q_check (must = Est Q_avg)	3.30 cfs	Tc= 8.36 min
Q Node 1-22/23=	5.32 cfs	Sum CA= 0.80
		Area= 1.11 acres

Land Use Element =  
Percentage of Basin =

n/a  
0.00%

From Table 3-1

0.35

$$Cp = 0.25 * 0.30 + 0.75 * 0.35 = 0.34$$

From Formula Page 3-5

$$C = \underline{0.73}$$

Percent Impervious =  
Percentage of Basin =

69.77%  
100.00%

Hydrologic Soil Group =

C/D

25/75 Split

Coefficient of Runoff =

0.73

Proportionate Average

PB 12 VC.txt  
Velocity Check for Proposed Basin 12  
 $Q_{avg} = 1.65 \text{ cfs}$  (1/2 for each gutter),  $S_{avg} = 14.10\%$

### Channel Calculator

#### Given Input Data:

Shape .....	Trapezoidal
Solving for .....	Depth of Flow
Flowrate .....	1.6500 cfs
Slope .....	0.1410 ft/ft
Manning's n .....	0.0150
Height .....	6.0000 in
Bottom width .....	0.0000 in
Left slope .....	3.0000 ft/ft (V/H)
Right slope .....	0.0200 ft/ft (V/H)

#### Computed Results:

Depth .....	1.3283 in
Velocity .....	5.3508 fps
Full Flowrate .....	91.9933 cfs
Flow area .....	0.3084 ft <sup>2</sup>
Flow perimeter .....	67.8289 in
Hydraulic radius .....	0.6547 in
Top width .....	66.8582 in
Area .....	6.2917 ft <sup>2</sup>
Perimeter .....	306.3845 in
Percent full .....	22.1385 %

#### Critical Information

Critical depth .....	2.3150 in
Critical slope .....	0.0073 ft/ft
Critical velocity .....	1.7617 fps
Critical area .....	0.9366 ft <sup>2</sup>
Critical perimeter .....	118.2130 in
Critical hydraulic radius .....	1.1409 in
Critical top width .....	116.5213 in
Specific energy .....	0.5556 ft
Minimum energy .....	0.2894 ft
Froude number .....	4.0098
Flow condition .....	Supercritical

TM 5401  
Proposed Basin 14

Rational Method  
100 Year Storm

1 AREA (A) = 29668.08 sq.ft. = 0.68 ACRES  
2 COEFFICIENT OF RUNOFF (C) COEFFICIENT "C"

LAND USE <u>NRCS ELEMENTS</u>	<u>DENSITY</u>	<u>% BASIN</u>	<u>% IMPERV.</u>	
UNDISTURBED NATURAL	OPEN	0	0	= 0.35
LOW DENSITY RESIDENTIAL	1.0 DU/A	0	10	= 0.41
LOW DENSITY RESIDENTIAL	2.0 DU/A	0	20	= 0.46
LOW DENSITY RESIDENTIAL	2.9 DU/A	0	25	= 0.49
MEDIUM DENSITY RESIDENTIAL	4.3 DU/A	49	30	= 0.52
MEDIUM DENSITY RESIDENTIAL	7.3 DU/A	0	40	= 0.57
MEDIUM DENSITY RESIDENTIAL	10.9 DU/A	0	45	= 0.60
MEDIUM DENSITY RESIDENTIAL	14.5 DU/A	0	50	= 0.63
HIGH DENSITY RESIDENTIAL	24 DU/A	0	65	= 0.71
HIGH DENSITY RESIDENTIAL	43.0 DU/A	0	80	= 0.79
COMMERCIAL/INDUSTRIAL	NEIGH.	0	80	= 0.79
COMMERCIAL/INDUSTRIAL	GEN. COM.	0	85	= 0.82
COMMERCIAL/INDUSTRIAL	OFFICE	0	90	= 0.85
COMMERCIAL/INDUSTRIAL	LIMITED	0	90	= 0.85
COMMERCIAL/INDUSTRIAL	GEN. IND.	0	95	= 0.87
PERCENT IMPERVIOUS		51.00	0.00	= 0.35
SOIL GROUP	<b>D</b>		CA = 0.30	C = 0.43

3 TIME OF CONCENTRATION (TC) - SHEET FLOW

$$\begin{aligned} \text{HIGH POINT (Hh)} &= 760 & \text{LOW POINT (Hl)} &= 757.6 \\ H = Hh - Hl &= 2.40 \text{ ft.} & S &= 1.0\% \\ L &= 233.00 \text{ ft.} \\ L_M &= 70.00 \text{ ft.} & \text{FROM TABLE 3-2.} & & 0.04 \text{ MILES} \\ T_i &= 9.94 \text{ MIN} \end{aligned}$$

4 INTENSITY (I) FOR FREQUENCY YEAR **100**

SEE ATTACHMENT 1 FOR PRECIPITATION MAPS FROM THE SAN DIEGO COUNTY HYDROLOGY MANUAL

$$\begin{aligned} A) P_6 &= 3.5 & P_{24} &= 6.0 & P_6/P_{24} &= 58.3\% \\ B) & & P_6(\text{ADJUSTED}) &= 3.5 \\ C) I &= 5.92 \text{ IN/HR } (I = 7.44 P_6 (T_C)^{-0.45}) \end{aligned}$$

5 RUNOFF (Q)

$$Q = CIA = 1.75 \text{ cfs} \quad \text{Node 1-14 to 1-15}$$

**Node -1-15 to 1-16*****Pr. Basin 15*****Data**

P <sub>6</sub> =	3.5 in	
P <sub>24</sub> =	6.0 in	
Area_Pr. Basin 15 (acres)	0.43	
Area_Pr. Node 1-15 (acres)	0.68	Upstream
C_Pr. Basin 15	0.35	See Below
CA_Upstream	0.30	Upstream

**Pr. Basin 15**

High point	757.60	
Low point	654.70	
Distance	543.91	Slope= 0.1892 18.92%

**Pr. Node 1-15**

Ti (min)	9.94	Upstream
I (in/hr)	5.92	CA_Pr. Basin 15= 0.15
Q Node 1-15	1.75	CA_Upstream= 0.30 SUM CA= 0.45

Final Area= 1.11 acres

Tt (Kirpich's)	Overland Flow	Tt = $(11.9 \cdot L^3 / (H_p - L_p))^{0.385}$
Tc=Ti+Tt	Figure 3-4	<u>Summary</u>
I (7.44P <sub>6</sub> (Tc) <sup>-0.645</sup> ) =	1.85 min	Q Node 1-16= 2.36 cfs
	11.80 min	I= 5.30 in/hr
	5.30 in/hr	Tc= 11.80 min
Q Node 1-16=	2.36 cfs	Sum CA= 0.45
		Area= 1.11 acres

Land Use Element =	n/a	From Table 3-1
Percentage of Basin =	0.00%	C = <u>0.35</u>
Percent Impervious =	0.00%	From Formula Page 3-5
Percentage of Basin =	100.00%	C = <u>0.35</u>
Hydrologic Soil Group =	D	
Coefficient of Runoff =	<u>0.35</u>	Proportionate Average

**Node -1-16 to 1-18*****Pr. Basin 16*****Data**

P <sub>6</sub> =	3.5 in	
P <sub>24</sub> =	6.0 in	
Area_Pr. Basin 16 (acres)	0.20	
Area_Pr. Node 1-16 (acres)	1.11	Upstream
C_Pr. Basin 16	0.35	See Below
CA_Upstream	0.45	Upstream

**Pr. Basin 16**

High point	653.70	
Low point	624.60	
Distance	330.95	Slope= 0.0879 8.79%

**Pr. Node 1-16**

Ti (min)	11.80	Upstream
I (in/hr)	5.30	CA_Pr. Basin 16= 0.07
Q Node 1-16	2.36	CA_Upstream= 0.45 SUM CA= 0.52

**Assumptions**

Estimate q_avg (cfs/acre)	1.2	Final Area= 1.32 acres
Qavg	2.49 cfs	

**Determine Velocity**

Velocity	Concrete Brow Ditch	
	6.11 fps	
Tt	0.90 min	<b>Summary</b>
Tc=Ti+Tt	12.70 min	Q Node 1-18= 2.61 cfs
I (7.44P <sub>6</sub> (Tc) <sup>-0.645</sup> ) =	5.05 in/hr	I= 5.05 in/hr
Q_check (must = Est Q_avg)	2.49 cfs	Tc= 12.70 min
Q Node 1-18=	<b>2.61 cfs</b>	Sum CA= 0.52
		Area= 1.32 acres

Land Use Element =	n/a	From Table 3-1
Percentage of Basin =	0.00%	C = 0.35
Percent Impervious =	0.00%	From Formula Page 3-5
Percentage of Basin =	100.00%	C = 0.35
Hydrologic Soil Group =	D	25/75 Split
Coefficient of Runoff =	<u>0.35</u>	Proportionate Average

PB 16 VC.txt

Velocity Check for Proposed Basin 16

Qavg = 2.49 cfs, Savg = 8.79%

Concrete Bowl Ditch

Channel Calculator

Given Input Data:

Shape .....	Advanced
Solving for .....	Depth of Flow
Flowrate .....	2.4900 cfs
Slope .....	0.0879 ft/ft
Manning's n .....	0.0150
Height .....	12.0000 in
Bottom width .....	0.0000 in
Left radius .....	12.0000 in
Right radius .....	12.0000 in
Left slope .....	1000.0000 ft/ft (V/H)
Right slope .....	1000.0000 ft/ft (V/H)

Computed Results:

Depth .....	5.0197 in
Velocity .....	6.1067 fps
Full Flowrate .....	29.0640 cfs
Flow area .....	0.4077 ft <sup>2</sup>
Flow perimeter .....	51.6117 in
Hydraulic radius .....	1.1376 in
Top width .....	23.9861 in
Area .....	1.5708 ft <sup>2</sup>
Perimeter .....	37.6991 in
Percent full .....	41.8308 %

Critical Information

Critical depth .....	6.9400 in
Critical slope .....	0.0115 ft/ft
Critical velocity .....	3.4220 fps
Critical area .....	0.7276 ft <sup>2</sup>
Critical perimeter .....	47.7712 in
Critical hydraulic radius .....	2.1934 in
Critical top width .....	23.9899 in
Specific energy .....	0.9978 ft
Minimum energy .....	0.8675 ft
Froude number .....	2.3837
Flow condition .....	Supercritical
Flow condition .....	Supercritical

TM 5401  
Proposed Basin 17

Rational Method  
100 Year Storm

1 AREA (A) = 31200.40 sq.ft. = 0.72 ACRES  
2 COEFFICIENT OF RUNOFF (C) COEFFICIENT "C"

LAND USE <u>NRCS ELEMENTS</u>	<u>DENSITY</u>	<u>% BASIN</u>	<u>% IMPERV.</u>	
UNDISTURBED NATURAL	OPEN	0	0	= 0.35
LOW DENSITY RESIDENTIAL	1.0 DU/A	0	10	= 0.41
LOW DENSITY RESIDENTIAL	2.0 DU/A	0	20	= 0.46
LOW DENSITY RESIDENTIAL	2.9 DU/A	57	25	= 0.49
MEDIUM DENSITY RESIDENTIAL	4.3 DU/A	0	30	= 0.52
MEDIUM DENSITY RESIDENTIAL	7.3 DU/A	0	40	= 0.57
MEDIUM DENSITY RESIDENTIAL	10.9 DU/A	0	45	= 0.60
MEDIUM DENSITY RESIDENTIAL	14.5 DU/A	0	50	= 0.63
HIGH DENSITY RESIDENTIAL	24 DU/A	0	65	= 0.71
HIGH DENSITY RESIDENTIAL	43.0 DU/A	0	80	= 0.79
COMMERCIAL/INDUSTRIAL	NEIGH.	0	80	= 0.79
COMMERCIAL/INDUSTRIAL	GEN. COM.	0	85	= 0.82
COMMERCIAL/INDUSTRIAL	OFFICE	0	90	= 0.85
COMMERCIAL/INDUSTRIAL	LIMITED	0	90	= 0.85
COMMERCIAL/INDUSTRIAL	GEN. IND.	0	95	= 0.87
PERCENT IMPERVIOUS		43.00	0.00	= 0.35
SOIL GROUP	<b>D</b>		CA = 0.31	C = 0.43

3 TIME OF CONCENTRATION (TC) - SHEET FLOW

$$\begin{aligned} \text{HIGH POINT (Hh)} &= 628 & \text{LOW POINT (Hl)} &= 624.6 \\ H = Hh - Hl &= 3.40 \text{ ft.} & S &= 1.3\% \\ L &= 271.00 \text{ ft.} \\ L_M &= 70.00 \text{ ft.} & \text{FROM TABLE 3-2.} & \\ T_i &= 9.37 \text{ MIN} & & \end{aligned}$$

4 INTENSITY (I) FOR FREQUENCY YEAR **100**

SEE ATTACHMENT 1 FOR PRECIPITATION MAPS FROM THE SAN DIEGO COUNTY HYDROLOGY MANUAL

$$\begin{aligned} A) P_6 &= 3.5 & P_{24} &= 6.0 & P_6/P_{24} &= 58.3\% \\ B) & & P_6(\text{ADJUSTED}) &= 3.5 \\ C) I &= 6.15 \text{ IN/HR } (I = 7.44 P_6 (T_C)^{-0.45}) \end{aligned}$$

5 RUNOFF (Q)

$$Q = CIA = 1.89 \text{ cfs} \quad \text{Node 1-17 to 1-18}$$

## **Junction Equation**

### ***Q for Node 1-18 - Proposed Conditions***

Arrange from the lowest Tc to highest Tc

**T1<T2<T3**

System	Q(cfs)	Tc(min)	I(in/hr)	A(acres)	Sum CA
Q Pr. Basin 17	1.89	9.37	6.15	0.72	0.31
Q Pr. Basin 16	2.61	12.70	5.05	1.32	0.52
				2.03	0.83

$$Qt_1 = Q_1 + (T_1/T_2) * Q_2 = 3.82 \text{ cfs}$$

$$Qt_2 = Q_2 + (I_2/I_1) * Q_1 = 4.17 \text{ cfs}$$

Select the largest Q and use the Tc associated with that Q:

If Q's are equal, use the lowest value:

Largest Q=	4.17 cfs
Tc associated=	12.70 min
Area(acres)=	2.03 acres
I(in/hr)=	5.05 in/hr

**Node -1-18 to 1-18.1*****Pr. Basin 18*****Data**

P <sub>6</sub> =	3.5 in	
P <sub>24</sub> =	6.0 in	
Area_Pr. Basin 18 (acres)	0.18	
Area_Pr. Node 1-18 (acres)	2.03	Upstream
C_Pr. Basin 18	0.35	See Below
CA_Upstream	0.83	Upstream

**Pr. Basin 18**

High point	624.60	
Low point	614.20	
Distance	108.92	Slope= 0.0955 9.55%

**Pr. Node 1-18**

T <sub>i</sub> (min)	12.70	Upstream
I (in/hr)	5.05	CA_Pr. Basin 18= 0.06
Q Node 1-18	4.17	CA_Upstream= 0.83 SUM CA= 0.89

Final Area= 2.21 acres

T <sub>t</sub> (Kirpich's)	Overland Flow	T <sub>t</sub> = $(11.9 \cdot L^3 / (H_p - L_p))^{0.385}$
T <sub>c</sub> =T <sub>i</sub> +T <sub>t</sub>	Figure 3-4	Summary
I (7.44P <sub>6</sub> (T <sub>c</sub> ) <sup>-0.645</sup> ) =	0.70 min	Q Node 1-18.1= 4.33 cfs
	13.40 min	I= 4.88 in/hr
	4.88 in/hr	T <sub>c</sub> = 13.40 min
Q Node 1-18.1=	4.33 cfs	Sum CA= 0.89
		Area= 2.21 acres

Land Use Element =	n/a	From Table 3-1
Percentage of Basin =	0.00%	C = 0.35
Percent Impervious =	0.00%	From Formula Page 3-5
Percentage of Basin =	100.00%	C = 0.35
Hydrologic Soil Group =	D	
Coefficient of Runoff =	0.35	Proportionate Average

TM 5401  
Proposed Basin 19

Rational Method  
100 Year Storm

1 AREA (A) = 23932.46 sq.ft. = 0.55 ACRES  
2 COEFFICIENT OF RUNOFF (C) COEFFICIENT "C"

LAND USE <u>NRCS ELEMENTS</u>	<u>DENSITY</u>	<u>% BASIN</u>	<u>% IMPERV.</u>	
UNDISTURBED NATURAL	OPEN	0	0	= 0.35
LOW DENSITY RESIDENTIAL	1.0 DU/A	0	10	= 0.41
LOW DENSITY RESIDENTIAL	2.0 DU/A	0	20	= 0.46
LOW DENSITY RESIDENTIAL	2.9 DU/A	80.42	25	= 0.49
MEDIUM DENSITY RESIDENTIAL	4.3 DU/A	0	30	= 0.52
MEDIUM DENSITY RESIDENTIAL	7.3 DU/A	0	40	= 0.57
MEDIUM DENSITY RESIDENTIAL	10.9 DU/A	0	45	= 0.60
MEDIUM DENSITY RESIDENTIAL	14.5 DU/A	0	50	= 0.63
HIGH DENSITY RESIDENTIAL	24 DU/A	0	65	= 0.71
HIGH DENSITY RESIDENTIAL	43.0 DU/A	0	80	= 0.79
COMMERCIAL/INDUSTRIAL	NEIGH.	0	80	= 0.79
COMMERCIAL/INDUSTRIAL	GEN. COM.	0	85	= 0.82
COMMERCIAL/INDUSTRIAL	OFFICE	0	90	= 0.85
COMMERCIAL/INDUSTRIAL	LIMITED	0	90	= 0.85
COMMERCIAL/INDUSTRIAL	GEN. IND.	0	95	= 0.87
PERCENT IMPERVIOUS		19.58	0.00	= 0.35
SOIL GROUP	<b>D</b>		CA = 0.25	C = 0.46

3 TIME OF CONCENTRATION (TC) - SHEET FLOW

HIGH POINT (Hh) = 618 LOW POINT (Hl) = 615.5  
 H = Hh - Hl = 2.50 ft. S = 1.0%  
 L = 249.00 ft.  
L<sub>M</sub> = 70.00 ft. FROM TABLE 3-2. 0.05 MILES  
 Ti = 9.59 MIN MINIMUM TIME OF CONCENTRATION = 5 MINUTES

4 INTENSITY (I) FOR FREQUENCY YEAR 100

SEE ATTACHMENT 1 FOR PRECIPITATION MAPS FROM THE SAN DIEGO COUNTY HYDROLOGY MANUAL

A) P<sub>6</sub> = 3.5 P<sub>24</sub> = 6.0 P<sub>6</sub>/P<sub>24</sub> = 58.3%  
 B) P<sub>6</sub>(ADJUSTED) = 3.5  
 C) I = 6.06 IN/HR (I=7.44P<sub>6</sub>(T<sub>C</sub>)<sup>-0.45</sup>)

5 RUNOFF (Q)

Q = CIA = 1.54 cfs Node 1-19 to 1-18.1

### **Junction Equation**

### ***Q for Node 1-18.1 - Proposed Conditions***

Arrange from the lowest Tc to highest Tc

**T1<T2<T3**

System	Q(cfs)	Tc(min)	I(in/hr)	A(acres)	Sum CA
Q Pr. Basin 19	1.54	9.59	6.06	0.55	0.25
Q Pr. Node 1-18.1	4.33	13.40	4.88	2.21	0.89
				2.76	1.14

$$Qt_1 = Q_1 + (T_1/T_2) * Q_2 = 4.64 \text{ cfs}$$

$$Qt_2 = Q_2 + (I_2/I_1) * Q_1 = 5.57 \text{ cfs}$$

Select the largest Q and use the Tc associated with that Q:

If Q's are equal, use the lowest value:

Largest Q=	5.57 cfs
Tc associated=	13.40 min
Area(acres)=	2.76 acres
I(in/hr)=	4.88 in/hr

**Node -1-18.1 to 1-20*****Pr. Basin 20a*****Data**

P <sub>6</sub> =	3.5 in	
P <sub>24</sub> =	6.0 in	
Area_Pr. Basin 20a (acres)	0.30	
Area_Pr. Node 1-18.1 (acres)	2.76	Upstream
C_Pr. Basin 20a	0.35	See Below
CA_Upstream	1.14	Upstream

**Pr. Basin 20a**

High point	614.20	
Low point	607.70	
Distance	148.47	Slope= 0.0438 4.38%

**Pr. Node 1-18.1**

T <sub>i</sub> (min)	13.40	Upstream
I (in/hr)	4.88	CA_Pr. Basin 20a= 0.10
Q Node 1-18.1	5.57	CA_Upstream= 1.14 SUM CA= 1.24

Final Area= 3.05 acres

T <sub>t</sub> (Kirpich's)	Overland Flow	T <sub>t</sub> = $(11.9 \cdot L^3 / (H_p - L_p))^{0.385}$
T <sub>c</sub> =T <sub>i</sub> +T <sub>t</sub>	Figure 3-4	Summary
I (7.44P <sub>6</sub> (T <sub>c</sub> ) <sup>-0.645</sup> ) =	1.20 min	Q Node 1-20= 5.75 cfs
	14.60 min	I= 4.62 in/hr
	4.62 in/hr	T <sub>c</sub> = 14.60 min
Q Node 1-20=	5.75 cfs	Sum CA= 1.24
		Area= 3.05 acres

Land Use Element =	n/a	From Table 3-1
Percentage of Basin =	0.00%	C = 0.35
Percent Impervious =	0.00%	From Formula Page 3-5
Percentage of Basin =	100.00%	C = 0.35
Hydrologic Soil Group =	D	
Coefficient of Runoff =	0.35	Proportionate Average

TM 5401  
Proposed Basin 13

Rational Method  
100 Year Storm

1 AREA (A) = 14275.73 sq.ft. = 0.33 ACRES  
2 COEFFICIENT OF RUNOFF (C) COEFFICIENT "C"

LAND USE <u>NRCS ELEMENTS</u>	<u>DENSITY</u>	<u>% BASIN</u>	<u>% IMPERV.</u>	
UNDISTURBED NATURAL	OPEN	0	0	= 0.30
LOW DENSITY RESIDENTIAL	1.0 DU/A	0	10	= 0.36
LOW DENSITY RESIDENTIAL	2.0 DU/A	0	20	= 0.42
LOW DENSITY RESIDENTIAL	2.9 DU/A	100	25	= 0.45
MEDIUM DENSITY RESIDENTIAL	4.3 DU/A	0	30	= 0.48
MEDIUM DENSITY RESIDENTIAL	7.3 DU/A	0	40	= 0.54
MEDIUM DENSITY RESIDENTIAL	10.9 DU/A	0	45	= 0.57
MEDIUM DENSITY RESIDENTIAL	14.5 DU/A	0	50	= 0.60
HIGH DENSITY RESIDENTIAL	24 DU/A	0	65	= 0.69
HIGH DENSITY RESIDENTIAL	43.0 DU/A	0	80	= 0.78
COMMERCIAL/INDUSTRIAL	NEIGH.	0	80	= 0.78
COMMERCIAL/INDUSTRIAL	GEN. COM.	0	85	= 0.81
COMMERCIAL/INDUSTRIAL	OFFICE	0	90	= 0.84
COMMERCIAL/INDUSTRIAL	LIMITED	0	90	= 0.84
COMMERCIAL/INDUSTRIAL	GEN. IND.	0	95	= 0.87
PERCENT IMPERVIOUS		0.00	0.00	= 0.30
SOIL GROUP	C		CA = 0.15	C = 0.45

3 TIME OF CONCENTRATION (TC) - SHEET FLOW

$$\begin{aligned} \text{HIGH POINT (Hh)} &= 615 & \text{LOW POINT (Hl)} &= 612.9 \\ H = Hh - Hl &= 2.10 \text{ ft.} & S &= 1.0\% \\ L &= 210.00 \text{ ft.} \\ L_M &= 70.00 \text{ ft.} & \text{FROM TABLE 3-2.} & & 0.04 \text{ MILES} \\ T_i &= 9.79 \text{ MIN} & \text{MINIMUM TIME OF CONCENTRATION} &= 5 \text{ MINUTES} \end{aligned}$$

4 INTENSITY (I) FOR FREQUENCY YEAR 100

SEE ATTACHMENT 1 FOR PRECIPITATION MAPS FROM THE SAN DIEGO COUNTY HYDROLOGY MANUAL

$$\begin{aligned} A) P_6 &= 3.5 & P_{24} &= 6.0 & P_6/P_{24} &= 58.3\% \\ B) & & P_6(\text{ADJUSTED}) &= 3.5 \\ C) I &= 5.98 \text{ IN/HR} \quad (I=7.44P_6(T_C)^{-0.45}) \end{aligned}$$

5 RUNOFF (Q)

$$Q = CIA = 0.88 \text{ cfs} \quad \text{Node 1-13 to 1-13.1}$$

Trave Time from Node 1-13.1 to 1-20       $T_i = 9.79 \text{ min}$     D-75 Type B Brow Ditch  
 $L = 47 \text{ ft} @ 11.06\%$        $V = 4.2 \text{ fps}$        $T_t = 0.19 \text{ min}$      $T_c = 9.69 + 0.19 = 9.88 \text{ min}$

### **Junction Equation**

#### ***Q for Node 1-20 - Proposed Conditions***

Arrange from the lowest  $T_c$  to highest  $T_c$

$T_1 < T_2 < T_3$

System	Q(cfs)	Tc(min)	I(in/hr)	A(acres)	Sum CA
Q Pr. Basin 13	0.88	9.88	5.94	0.33	0.15
Q Pr. Basin 20a	5.75	14.60	4.62	3.05	1.24
				3.38	1.39

$$Q_{t1} = Q_1 + (T_1/T_2) * Q_2 = 4.77 \text{ cfs}$$

$$Q_{t2} = Q_2 + (I_2/I_1) * Q_1 = 6.44 \text{ cfs}$$

Select the largest Q and use the  $T_c$  associated with that Q:

If Q's are equal, use the lowest value:

Largest Q=	6.44 cfs
Tc associated=	14.60 min
Area(acres)=	3.38 acres
I(in/hr)=	4.62 in/hr

Node 1-13.1 to 1-20 BD.txt  
 Velocity Check for Concrete Brow Ditch from  
 Node 1-13.1 to 1-20  
 24" BD @ 11.06 %

#### Channel Calculator

##### Given Input Data:

Shape .....	Advanced
Solving for .....	Depth of Flow
Flowrate .....	0.8800 cfs
Slope .....	0.1106 ft/ft
Manning's n .....	0.0150
Height .....	12.0000 in
Bottom width .....	0.0000 in
Left radius .....	12.0000 in
Right radius .....	12.0000 in
Left slope .....	1000.0000 ft/ft (V/H)
Right slope .....	1000.0000 ft/ft (V/H)

##### Computed Results:

Depth .....	3.8184 in
Velocity .....	4.2378 fps
Full Flowrate .....	32.6016 cfs
Flow area .....	0.2077 ft <sup>2</sup>
Flow perimeter .....	54.0144 in
Hydraulic radius .....	0.5536 in
Top width .....	23.9836 in
Area .....	1.5708 ft <sup>2</sup>
Perimeter .....	37.6991 in
Percent full .....	31.8196 %

##### Critical Information

Critical depth .....	4.7552 in
Critical slope .....	0.0163 ft/ft
Critical velocity .....	2.4196 fps
Critical area .....	0.3637 ft <sup>2</sup>
Critical perimeter .....	52.1406 in
Critical hydraulic radius .....	1.0045 in
Critical top width .....	23.9855 in
Specific energy .....	0.5973 ft
Minimum energy .....	0.5944 ft
Froude number .....	2.3179
Flow condition .....	Supercritical

**Node -1-20 to 1-22*****Pr. Basin 20b*****Data**

P <sub>6</sub> =	3.5 in
P <sub>24</sub> =	6.0 in
Area_Pr. Basin 20b (acres)	0.31
Area_Pr. Node 1-20 (acres)	3.38
C_Pr. Basin 20b	0.35
CA_Upstream	1.39

**Pr. Basin 20b**

High point	607.70			
Low point	594.50			
Distance	259.58	Slope=	0.0509	5.09%

**Pr. Node 1-20**

Ti (min)	14.60	Upstream
I (in/hr)	4.62	CA_Pr. Basin 20b= 0.11
Q Node 1-20	6.44	CA_Upstream= 1.39 SUM CA= 1.50

**Assumptions**

Estimate q_avg (cfs/acre)	1.05	Final Area= 3.69 acres
Qavg	<b>6.60 cfs</b>	

**Determine Velocity**

Velocity	Concrete Brow Ditch
	<b>7.97 fps</b>
Tt	0.54 min
Tc=Ti+Tt	15.14 min
I (7.44P <sub>6</sub> (Tc) <sup>-0.645</sup> ) =	4.51 in/hr
Q_check (must = Est Q_avg)	6.60 cfs
Q Node 1-22=	<b>6.77 cfs</b>

**Summary**

Q Node 1-22=	6.77 cfs
I=	4.51 in/hr
Tc=	15.14 min
Sum CA=	1.50
Area=	3.69 acres

Land Use Element =	n/a	From Table 3-1
Percentage of Basin =	0.00%	C = <b>0.35</b>
Percent Impervious =	0.00%	From Formula Page 3-5
Percentage of Basin =	100.00%	C = <b>0.35</b>
Hydrologic Soil Group =	<b>D</b>	25/75 Split
Coefficient of Runoff =	<u>0.35</u>	Proportionate Average

Node 1-20 to 1-22 BD1.txt  
Velocity Check for Concrete Brow Ditch from  
Node 1-20 to 1-22  
24" BD @ 5.09%

#### Channel Calculator

##### Given Input Data:

Shape .....	Advanced
Solving for .....	Depth of Flow
Flowrate .....	6.6000 cfs
Slope .....	0.0509 ft/ft
Manning's n .....	0.0150
Height .....	12.0000 in
Bottom width .....	0.0000 in
Left radius .....	12.0000 in
Right radius .....	12.0000 in
Left slope .....	1000.0000 ft/ft (V/H)
Right slope .....	1000.0000 ft/ft (V/H)

##### Computed Results:

Depth .....	7.5390 in
Velocity .....	7.9764 fps
Full Flowrate .....	22.1167 cfs
Flow area .....	0.8274 ft <sup>2</sup>
Flow perimeter .....	46.5731 in
Hydraulic radius .....	2.5584 in
Top width .....	23.9911 in
Area .....	1.5708 ft <sup>2</sup>
Perimeter .....	37.6991 in
Percent full .....	62.8252 %

##### Critical Information

Critical depth .....	10.9378 in
Critical slope .....	0.0073 ft/ft
Critical velocity .....	4.7354 fps
Critical area .....	1.3938 ft <sup>2</sup>
Critical perimeter .....	39.7755 in
Critical hydraulic radius .....	5.0459 in
Critical top width .....	23.9979 in
Specific energy .....	1.6170 ft
Minimum energy .....	1.3672 ft
Froude number .....	2.1859
Flow condition .....	Supercritical

## **Junction Equation**

### ***Q for Node 1-22 - Proposed Conditions***

Arrange from the lowest Tc to highest Tc

**T1<T2<T3**

System	Q(cfs)	Tc(min)	I(in/hr)	A(acres)	Sum CA
Q Pr. Basin 12	2.66	8.36	6.62	0.55	0.40
Q Pr. Node 1-22	6.77	15.14	4.51	3.69	1.50
				4.24	1.90

$$Qt_1 = Q_1 + (T_1/T_2) * Q_2 = 6.40 \text{ cfs}$$

$$Qt_2 = Q_2 + (I_2/I_1) * Q_1 = 8.58 \text{ cfs}$$

Select the largest Q and use the Tc associated with that Q:

If Q's are equal, use the lowest value:

Largest Q=	8.58 cfs
Tc associated=	15.14 min
Area(acres)=	4.24 acres
I(in/hr)=	4.51 in/hr

Travel Time from Node 1-22 to Node 1-23 SD-3 18" PVC Storm Drain L = 26 ft  
V = 6.63 fps Tt = 0.07 min Ti = 15.14 min Tc = 15.14 + 0.07 = 15.21 min

### **Junction Equation**

#### ***Q for Node 1-23 - Proposed Conditions***

Arrange from the lowest Tc to highest Tc

T1 < T2 < T3

System	Q(cfs)	Tc(min)	I(in/hr)	A(acres)	Sum CA
Q Pr. Basin 12	2.66	8.36	6.62	0.55	0.40
Q Pr. Node 1-22	8.58	15.21	4.50	4.24	1.90
				4.80	2.30

$$Qt_1 = Q_1 + (T_1/T_2) * Q_2 = 7.38 \text{ cfs}$$

$$Qt_2 = Q_2 + (I_2/I_1) * Q_1 = 10.39 \text{ cfs}$$

Select the largest Q and use the Tc associated with that Q:

If Q's are equal, use the lowest value:

Largest Q=	10.39 cfs
Tc associated=	15.21 min
Area(acres)=	4.80 acres
I(in/hr)=	4.50 in/hr

SD-03. txt

SD-3  
Q = 8.58 cfs, S = 1%  
18" PVC Storm Drain

Manning Pipe Calculator

Given Input Data:

Shape .....	Circular
Solving for .....	Depth of Flow
Diameter .....	18.0000 in
Flowrate .....	8.5800 cfs
Slope .....	0.0100 ft/ft
Manning's n .....	0.0130

Computed Results:

Depth .....	12.3670 in
Area .....	1.7671 ft <sup>2</sup>
Wetted Area .....	1.2944 ft <sup>2</sup>
Wetted Perimeter .....	35.1763 in
Perimeter .....	56.5487 in
Velocity .....	6.6285 fps
Hydraulic Radius .....	5.2989 in
Percent Full .....	68.7058 %
Full flow Flowrate .....	10.5043 cfs
Full flow velocity .....	5.9442 fps

Critical Information

Critical depth .....	13.9987 in
Critical slope .....	0.0067 ft/ft
Critical velocity .....	5.6881 fps
Critical area .....	1.5084 ft <sup>2</sup>
Critical perimeter .....	38.2718 in
Critical hydraulic radius .....	5.6755 in
Critical top width .....	18.0000 in
Specific energy .....	1.7092 ft
Minimum energy .....	1.7498 ft
Froude number .....	1.2673
Flow condition .....	Supercritical

Travel Time from Node 1-23 to Node 1-24 SD-2 18" PVC Storm Drain L = 245 ft  
 $V = 11.76 \text{ fps}$   $T_t = 0.35 \text{ min}$   $T_i = 15.21 \text{ min}$   $T_c = 15.21 + 0.35 = 15.56 \text{ min}$

### **Junction Equation**

#### ***Q for Node 1-24 - Proposed Conditions***

Arrange from the lowest Tc to highest Tc

$T_1 < T_2 < T_3$

System	Q(cfs)	Tc(min)	I(in/hr)	A(acres)	Sum CA
Q Pr. Basin 10A	0.81	8.91	6.35	0.37	0.13
Q Pr. Basin 10	9.28	14.56	4.63	5.05	1.96
Q Pr. Node 1-23	10.39	15.56	4.43	4.80	2.30
				10.22	4.39

$$Qt_1 = Q_1 + (T_1/T_2) * Q_2 + (T_1/T_3) * Q_3 = 12.44 \text{ cfs}$$

$$Qt_2 = Q_2 + (I_2/I_1) * Q_1 + (T_2/T_3) * Q_3 = 19.60 \text{ cfs}$$

$$Qt_3 = Q_3 + (I_3/I_1) * Q_1 + (I_3/I_2) * Q_2 = 19.85 \text{ cfs}$$

Select the largest Q and use the Tc associated with that Q:

If Q's are equal, use the lowest value:

Largest Q=	19.85 cfs
Tc associated=	15.56 min
Area(acres)=	10.22 acres
I(in/hr)=	4.43 in/hr

SD-02. txt

SD-2  
Q = 10.40 cfs, S = 3.92%  
18" PVC Storm Drain

Manning Pipe Calculator

Given Input Data:

Shape .....	Circular
Solving for .....	Depth of Flow
Diameter .....	18.0000 in
Flowrate .....	10.4000 cfs
Slope .....	0.0392 ft/ft
Manning's n .....	0.0130

Computed Results:

Depth .....	9.0006 in
Area .....	1.7671 ft <sup>2</sup>
Wetted Area .....	0.8837 ft <sup>2</sup>
Wetted Perimeter .....	28.2756 in
Perimeter .....	56.5487 in
Velocity .....	11.7693 fps
Hydraulic Radius .....	4.5002 in
Percent Full .....	50.0035 %
Full flow Flowrate .....	20.7975 cfs
Full flow velocity .....	11.7690 fps

Critical Information

Critical depth .....	15.6499 in
Critical slope .....	0.0072 ft/ft
Critical velocity .....	6.0648 fps
Critical area .....	1.7148 ft <sup>2</sup>
Critical perimeter .....	41.5742 in
Critical hydraulic radius .....	5.9396 in
Critical top width .....	18.0000 in
Specific energy .....	2.9027 ft
Minimum energy .....	1.9562 ft
Froude number .....	2.7034
Flow condition .....	Supercritical

**Node -2-2 to 2-3*****Pr. Basin 21*****Data**

P <sub>6</sub> =	3.5 in	
P <sub>24</sub> =	6.0 in	
Area_Pr. Basin 21 (acres)	0.47	
Area_Offsite Basin 2 (acres)	1.15	Upstream
C_Pr. Basin 21	0.90	See Below
CA_Upstream	0.41	Upstream

**Pr. Basin 21**

High point	600.00	
Low point	584.20	
Distance	455.72	Slope= 0.0347 3.47%

**Pr. Node 3-8**

Ti (min)	9.37	Upstream
I (in/hr)	6.15	CA_Pr. Basin 21= 0.42
Q Node 2-2	2.55	CA_Upstream= 0.41 SUM CA= 0.84

**Assumptions**

Estimate q_avg (cfs/acre)	4.25	Final Area= 1.62 acres
Qavg	3.55 cfs	

**Determine Velocity**

Velocity	Street Flow - AC Berm
	3.83 fps
Tt	1.98 min
Tc=Ti+Tt	11.35 min
I (7.44P <sub>6</sub> (Tc) <sup>-0.645</sup> ) =	5.43 in/hr
Q_check (must = Est Q_avg)	3.55 cfs
Q Node 2-3=	4.55 cfs

**Summary**

Q Node 2-3=	4.55 cfs
I=	5.43 in/hr
Tc=	11.35 min
Sum CA=	0.84
Area=	1.62 acres

Land Use Element =	n/a	From Table 3-1
Percentage of Basin =	0.00%	C = 0.35
Percent Impervious =	100.00%	From Formula Page 3-5
Percentage of Basin =	100.00%	C = 0.90
Hydrologic Soil Group =	C	
Coefficient of Runoff =	0.90	Proportionate Average

PB 21.txt

Velocity Check for Proposed Basin 21

Qavg = 3.55 cfs, Savg = 3.47%

Street Flow - AC Berm (Smooth Finish)

Channel Calculator

Given Input Data:

Shape .....	Trapezoidal
Solving for .....	Depth of Flow
Flowrate .....	3.5500 cfs
Slope .....	0.0347 ft/ft
Manning's n .....	0.0150
Height .....	6.0000 in
Bottom width .....	0.0000 in
Left slope .....	3.0000 ft/ft (V/H)
Right slope .....	0.0200 ft/ft (V/H)

Computed Results:

Depth .....	2.3027 in
Velocity .....	3.8307 fps
Full Flowrate .....	45.6364 cfs
Flow area .....	0.9267 ft <sup>2</sup>
Flow perimeter .....	117.5874 in
Hydraulic radius .....	1.1349 in
Top width .....	115.9046 in
Area .....	6.2917 ft <sup>2</sup>
Perimeter .....	306.3845 in
Percent full .....	38.3790 %

Critical Information

Critical depth .....	3.1452 in
Critical slope .....	0.0066 ft/ft
Critical velocity .....	2.0534 fps
Critical area .....	1.7289 ft <sup>2</sup>
Critical perimeter .....	160.6064 in
Critical hydraulic radius .....	1.5501 in
Critical top width .....	158.3080 in
Specific energy .....	0.4199 ft
Minimum energy .....	0.3931 ft
Froude number .....	2.1802
Flow condition .....	Supercritical

Travel Time from Node 1-24 to Node 2-3 SD-1 24" RCP Storm Drain L = 34 ft  
V = 8.12 fps Tt = 0.07 min Ti = 15.56 min Tc = 15.56 + 0.07 = 15.63 min

### **Junction Equation**

#### ***Q for Node 1-23 - Proposed Conditions***

Arrange from the lowest Tc to highest Tc

**T1<T2<T3**

System	Q(cfs)	Tc(min)	I(in/hr)	A(acres)	Sum CA
Q Pr. Basin 21	4.55	11.35	5.43	1.62	0.84
Q Pr. Node 1-24	19.85	15.63	4.42	10.22	4.39
				11.84	5.23

$$Qt_1 = Q_1 + (T_1/T_2) * Q_2 = 18.97 \text{ cfs}$$

$$Qt_2 = Q_2 + (I_2/I_1) * Q_1 = 23.55 \text{ cfs}$$

Select the largest Q and use the Tc associated with that Q:

If Q's are equal, use the lowest value:

Largest Q=	23.55 cfs
Tc associated=	15.63 min
Area(acres)=	11.84 acres
I(in/hr)=	4.42 in/hr

SD-01. txt

SD-1  
Q = 19.85 cfs, S = 1%  
24" RCP Storm Drain

Manning Pipe Calculator

Given Input Data:

Shape .....	Circular
Solving for .....	Depth of Flow
Diameter .....	24.0000 in
Flowrate .....	19.8500 cfs
Slope .....	0.0100 ft/ft
Manning's n .....	0.0130

Computed Results:

Depth .....	17.4314 in
Area .....	3.1416 ft <sup>2</sup>
Wetted Area .....	2.4441 ft <sup>2</sup>
Wetted Perimeter .....	48.9718 in
Perimeter .....	75.3982 in
Velocity .....	8.1216 fps
Hydraulic Radius .....	7.1868 in
Percent Full .....	72.6306 %
Full flow Flowrate .....	22.6224 cfs
Full flow velocity .....	7.2009 fps

Critical Information

Critical depth .....	20.0000 in
Critical slope .....	0.0064 ft/ft
Critical velocity .....	6.8351 fps
Critical area .....	2.9041 ft <sup>2</sup>
Critical perimeter .....	53.6991 in
Critical hydraulic radius .....	7.7877 in
Critical top width .....	24.0000 in
Specific energy .....	2.4691 ft
Minimum energy .....	2.5000 ft
Froude number .....	1.3121
Flow condition .....	Supercritical

## **HYDRAULIC CALCULATIONS**

## **Manning's Calculations**

DS-1.txt

Vegetated Swale DS-1  
B = 10 ft, X-Slope 3:1

Channel Calculator

Given Input Data:

Shape .....	Trapezoidal
Solving for .....	Depth of Flow
Flowrate .....	7.8400 cfs
Slope .....	0.0575 ft/ft
Manning's n .....	0.0600
Height .....	6.0000 in
Bottom width .....	120.0000 in
Left slope .....	0.3300 ft/ft (V/H)
Right slope .....	0.3300 ft/ft (V/H)

Computed Results:

Depth .....	3.5028 in
Velocity .....	2.4676 fps
Full Flowrate .....	19.6750 cfs
Flow area .....	3.1772 ft <sup>2</sup>
Flow perimeter .....	142.3552 in
Hydraulic radius .....	3.2139 in
Top width .....	141.2291 in
Area .....	5.7576 ft <sup>2</sup>
Perimeter .....	158.2925 in
Percent full .....	58.3801 %

Critical Information

Critical depth .....	3.1222 in
Critical slope .....	0.0849 ft/ft
Critical velocity .....	2.7930 fps
Critical area .....	2.8070 ft <sup>2</sup>
Critical perimeter .....	139.9262 in
Critical hydraulic radius .....	2.8887 in
Critical top width .....	138.9225 in
Specific energy .....	0.3865 ft
Minimum energy .....	0.3903 ft
Froude number .....	0.8373
Flow condition .....	Subcritical

DS-2. txt

Ri prop\_Lined\_Swale DS-2  
 B = 5 ft, X-Slope = 3:1

Channel Calculator

Given Input Data:

Shape .....	Trapezoidal
Solving for .....	Depth of Flow
Flowrate .....	2.3600 cfs
Slope .....	0.1910 ft/ft
Manning's n .....	0.0400
Height .....	6.0000 in
Bottom width .....	60.0000 in
Left slope .....	0.3300 ft/ft (V/H)
Right slope .....	0.3300 ft/ft (V/H)

Computed Results:

Depth .....	1.4178 in
Velocity .....	3.7279 fps
Full Flowrate .....	28.6027 cfs
Flow area .....	0.6331 ft <sup>2</sup>
Flow perimeter .....	69.0488 in
Hydraulic radius .....	1.3203 in
Top width .....	68.5930 in
Area .....	3.2576 ft <sup>2</sup>
Perimeter .....	98.2925 in
Percent full .....	23.6307 %

Critical Information

Critical depth .....	2.2009 in
Critical slope .....	0.0429 ft/ft
Critical velocity .....	2.3161 fps
Critical area .....	1.0190 ft <sup>2</sup>
Critical perimeter .....	74.0461 in
Critical hydraulic radius .....	1.9816 in
Critical top width .....	73.3386 in
Specific energy .....	0.3341 ft
Minimum energy .....	0.2751 ft
Froude number .....	1.9748
Flow condition .....	Supercritical

DS-3. txt

Vegetated Swale DS-3  
B = 5 ft, X-Slope = 3:1

Channel Calculator

Given Input Data:

Shape .....	Trapezoidal
Solving for .....	Depth of Flow
Flowrate .....	4.3300 cfs
Slope .....	0.0955 ft/ft
Manning's n .....	0.0600
Height .....	6.0000 in
Bottom width .....	60.0000 in
Left slope .....	0.3300 ft/ft (V/H)
Right slope .....	0.3300 ft/ft (V/H)

Computed Results:

Depth .....	3.1440 in
Velocity .....	2.8524 fps
Full Flowrate .....	13.4834 cfs
Flow area .....	1.5180 ft <sup>2</sup>
Flow perimeter .....	80.0653 in
Hydraulic radius .....	2.7302 in
Top width .....	79.0546 in
Area .....	3.2576 ft <sup>2</sup>
Perimeter .....	98.2925 in
Percent full .....	52.4001 %

Critical Information

Critical depth .....	3.2375 in
Critical slope .....	0.0863 ft/ft
Critical velocity .....	2.7588 fps
Critical area .....	1.5695 ft <sup>2</sup>
Critical perimeter .....	80.6622 in
Critical hydraulic radius .....	2.8020 in
Critical top width .....	79.6214 in
Specific energy .....	0.3884 ft
Minimum energy .....	0.4047 ft
Froude number .....	1.0476
Flow condition .....	Supercritical

DS-4. txt

Vegetated Swale DS-4  
B = 5 ft, X-Slope = 3:1

Channel Calculator

Given Input Data:

Shape .....	Trapezoidal
Solving for .....	Depth of Flow
Flowrate .....	6.4400 cfs
Slope .....	0.0430 ft/ft
Manning's n .....	0.0600
Height .....	6.0000 in
Bottom width .....	60.0000 in
Left slope .....	0.3300 ft/ft (V/H)
Right slope .....	0.3300 ft/ft (V/H)

Computed Results:

Depth .....	4.9579 in
Velocity .....	2.4932 fps
Full Flowrate .....	9.0476 cfs
Flow area .....	2.5831 ft <sup>2</sup>
Flow perimeter .....	91.6417 in
Hydraulic radius .....	4.0589 in
Top width .....	90.0479 in
Area .....	3.2576 ft <sup>2</sup>
Perimeter .....	98.2925 in
Percent full .....	82.6317 %

Critical Information

Critical depth .....	4.1495 in
Critical slope .....	0.0805 ft/ft
Critical velocity .....	3.0794 fps
Critical area .....	2.0913 ft <sup>2</sup>
Critical perimeter .....	86.4827 in
Critical hydraulic radius .....	3.4822 in
Critical top width .....	85.1488 in
Specific energy .....	0.5098 ft
Minimum energy .....	0.5187 ft
Froude number .....	0.7492
Flow condition .....	Subcritical

SD-01. txt

SD-1  
Q = 19.85 cfs, S = 1%  
24" RCP Storm Drain

Manning Pipe Calculator

Given Input Data:

Shape .....	Circular
Solving for .....	Depth of Flow
Diameter .....	24.0000 in
Flowrate .....	19.8500 cfs
Slope .....	0.0100 ft/ft
Manning's n .....	0.0130

Computed Results:

Depth .....	17.4314 in
Area .....	3.1416 ft <sup>2</sup>
Wetted Area .....	2.4441 ft <sup>2</sup>
Wetted Perimeter .....	48.9718 in
Perimeter .....	75.3982 in
Velocity .....	8.1216 fps
Hydraulic Radius .....	7.1868 in
Percent Full .....	72.6306 %
Full flow Flowrate .....	22.6224 cfs
Full flow velocity .....	7.2009 fps

Critical Information

Critical depth .....	20.0000 in
Critical slope .....	0.0064 ft/ft
Critical velocity .....	6.8351 fps
Critical area .....	2.9041 ft <sup>2</sup>
Critical perimeter .....	53.6991 in
Critical hydraulic radius .....	7.7877 in
Critical top width .....	24.0000 in
Specific energy .....	2.4691 ft
Minimum energy .....	2.5000 ft
Froude number .....	1.3121
Flow condition .....	Supercritical

SD-02. txt

SD-2  
Q = 10.40 cfs, S = 3.92%  
18" PVC Storm Drain

Manning Pipe Calculator

Given Input Data:

Shape .....	Circular
Solving for .....	Depth of Flow
Diameter .....	18.0000 in
Flowrate .....	10.4000 cfs
Slope .....	0.0392 ft/ft
Manning's n .....	0.0130

Computed Results:

Depth .....	9.0006 in
Area .....	1.7671 ft <sup>2</sup>
Wetted Area .....	0.8837 ft <sup>2</sup>
Wetted Perimeter .....	28.2756 in
Perimeter .....	56.5487 in
Velocity .....	11.7693 fps
Hydraulic Radius .....	4.5002 in
Percent Full .....	50.0035 %
Full flow Flowrate .....	20.7975 cfs
Full flow velocity .....	11.7690 fps

Critical Information

Critical depth .....	15.6499 in
Critical slope .....	0.0072 ft/ft
Critical velocity .....	6.0648 fps
Critical area .....	1.7148 ft <sup>2</sup>
Critical perimeter .....	41.5742 in
Critical hydraulic radius .....	5.9396 in
Critical top width .....	18.0000 in
Specific energy .....	2.9027 ft
Minimum energy .....	1.9562 ft
Froude number .....	2.7034
Flow condition .....	Supercritical

SD-03. txt

SD-3  
Q = 8.58 cfs, S = 1%  
18" PVC Storm Drain

Manning Pipe Calculator

Given Input Data:

Shape .....	Circular
Solving for .....	Depth of Flow
Diameter .....	18.0000 in
Flowrate .....	8.5800 cfs
Slope .....	0.0100 ft/ft
Manning's n .....	0.0130

Computed Results:

Depth .....	12.3670 in
Area .....	1.7671 ft <sup>2</sup>
Wetted Area .....	1.2944 ft <sup>2</sup>
Wetted Perimeter .....	35.1763 in
Perimeter .....	56.5487 in
Velocity .....	6.6285 fps
Hydraulic Radius .....	5.2989 in
Percent Full .....	68.7058 %
Full flow Flowrate .....	10.5043 cfs
Full flow velocity .....	5.9442 fps

Critical Information

Critical depth .....	13.9987 in
Critical slope .....	0.0067 ft/ft
Critical velocity .....	5.6881 fps
Critical area .....	1.5084 ft <sup>2</sup>
Critical perimeter .....	38.2718 in
Critical hydraulic radius .....	5.6755 in
Critical top width .....	18.0000 in
Specific energy .....	1.7092 ft
Minimum energy .....	1.7498 ft
Froude number .....	1.2673
Flow condition .....	Supercritical

Berm1.txt

Capacity Check buena Creek Road  
Q = 3.55 cfs, Savg = 3.47%  
Street Flow - AC Berm (Smooth Finish)

Channel Calculator

Given Input Data:

Shape .....	Trapezoidal
Solving for .....	Depth of Flow
Flowrate .....	3.5500 cfs
Slope .....	0.0347 ft/ft
Manning's n .....	0.0150
Height .....	6.0000 in
Bottom width .....	0.0000 in
Left slope .....	3.0000 ft/ft (V/H)
Right slope .....	0.0200 ft/ft (V/H)

Computed Results:

Depth .....	2.3027 in
Velocity .....	3.8307 fps
Full Flowrate .....	45.6364 cfs
Flow area .....	0.9267 ft <sup>2</sup>
Flow perimeter .....	117.5874 in
Hydraulic radius .....	1.1349 in
Top width .....	115.9046 in
Area .....	6.2917 ft <sup>2</sup>
Perimeter .....	306.3845 in
Percent full .....	38.3790 %

Critical Information

Critical depth .....	3.1452 in
Critical slope .....	0.0066 ft/ft
Critical velocity .....	2.0534 fps
Critical area .....	1.7289 ft <sup>2</sup>
Critical perimeter .....	160.6064 in
Critical hydraulic radius .....	1.5501 in
Critical top width .....	158.3080 in
Specific energy .....	0.4199 ft
Minimum energy .....	0.3931 ft
Froude number .....	2.1802
Flow condition .....	Supercritical

### Culvert 1.txt

Culvert Sizing Calculation  
S = 0.5%, Q = 23.55 cfs  
36" RCP Culvert

#### Manning Pipe Calculator

##### Given Input Data:

Shape .....	Circular
Solving for .....	Depth of Flow
Diameter .....	36.0000 in
Flowrate .....	23.5500 cfs
Slope .....	0.0050 ft/ft
Manning's n .....	0.0130

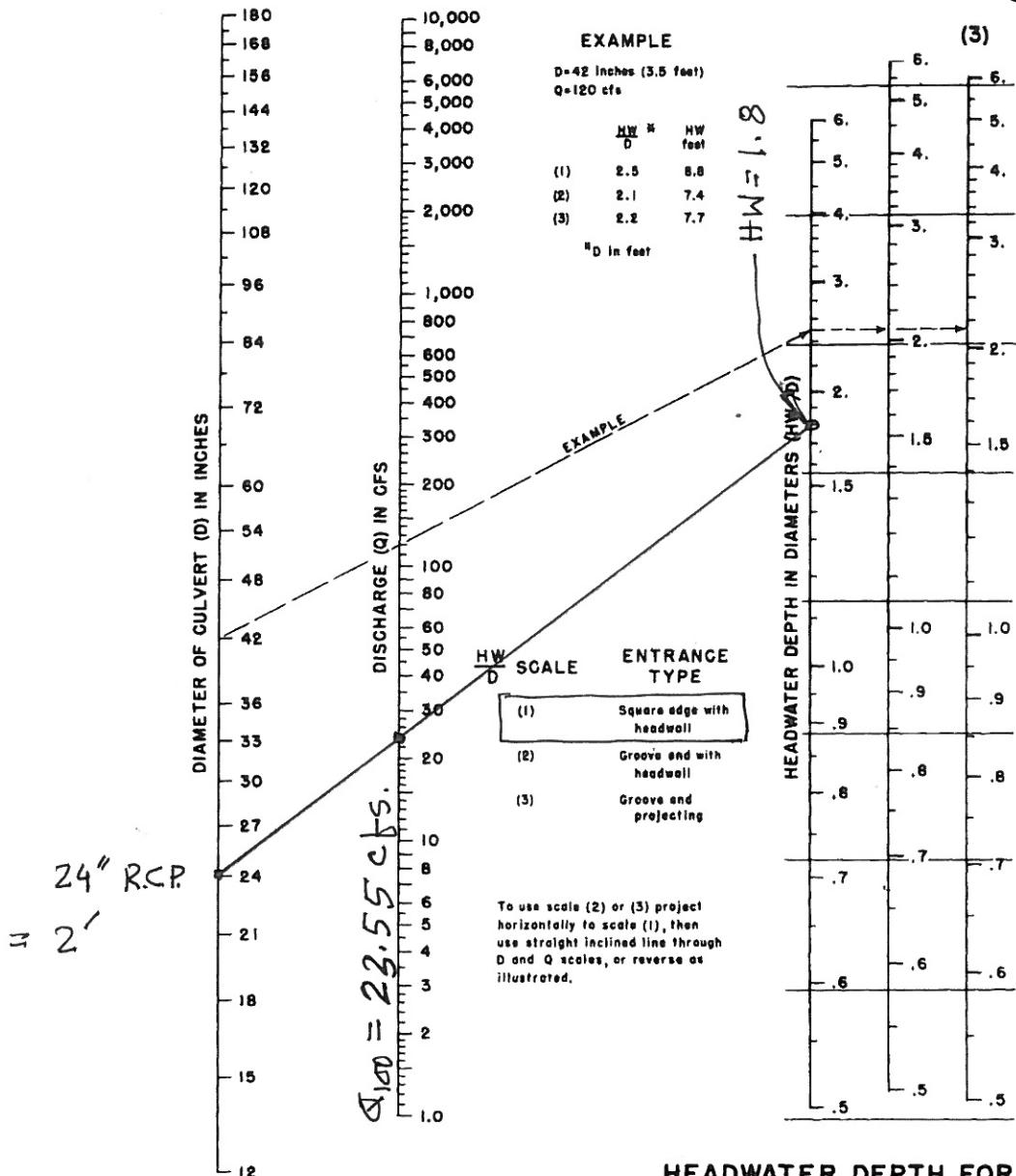
##### Computed Results:

Depth .....	17.9859 in
Area .....	7.0686 ft <sup>2</sup>
Wetted Area .....	3.5308 ft <sup>2</sup>
Wetted Perimeter .....	56.5204 in
Perimeter .....	113.0973 in
Velocity .....	6.6700 fps
Hydraulic Radius .....	8.9955 in
Percent Full .....	49.9607 %
Full flow Flowrate .....	47.1629 cfs
Full flow velocity .....	6.6722 fps

##### Critical Information

Critical depth .....	18.7653 in
Critical slope .....	0.0043 ft/ft
Critical velocity .....	6.3211 fps
Critical area .....	3.7256 ft <sup>2</sup>
Critical perimeter .....	58.0793 in
Critical hydraulic radius .....	9.2372 in
Critical top width .....	36.0000 in
Specific energy .....	2.1902 ft
Minimum energy .....	2.3457 ft
Froude number .....	1.0839
Flow condition .....	Supercritical

## CHART 1B



HEADWATER SCALES 283  
REVISED MAY 1964  
BUREAU OF PUBLIC ROADS JAN. 1963

### HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

$$HW/D = 1.8$$

$$HW = 1.8 \times 2 = 3.6'$$

$$\left| \begin{array}{l} F.L. = 579.23 \\ EL. HW = 579.23 + 3.6 = 582.83 \\ \text{Gutter Flow Line} = 584.21 \end{array} \right.$$

C-5

> EL.HW

24" R.C.P. OK

# OB 3 CC.txt

Maximum Capacity Check  
Existing Dri veway  
Offsite Basin 3

## Channel Calculator

### Given Input Data:

Shape .....	Trapezoidal
Solving for .....	Flowrate
Slope .....	0.0595 ft/ft
Manning's n .....	0.0160
Depth .....	2.6000 in
Height .....	4.0000 in
Bottom width .....	0.0000 in
Left slope .....	1000.0000 ft/ft (V/H)
Right slope .....	0.0200 ft/ft (V/H)

### Computed Results:

Flowrate .....	5.9623 cfs
Velocity .....	5.0802 fps
Full Flowrate .....	18.8067 cfs
Flow area .....	1.1736 ft <sup>2</sup>
Flow perimeter .....	132.6260 in
Hydraulic radius .....	1.2743 in
Top width .....	130.0026 in
Area .....	2.7778 ft <sup>2</sup>
Perimeter .....	204.0400 in
Percent full .....	65.0000 %

### Critical Information

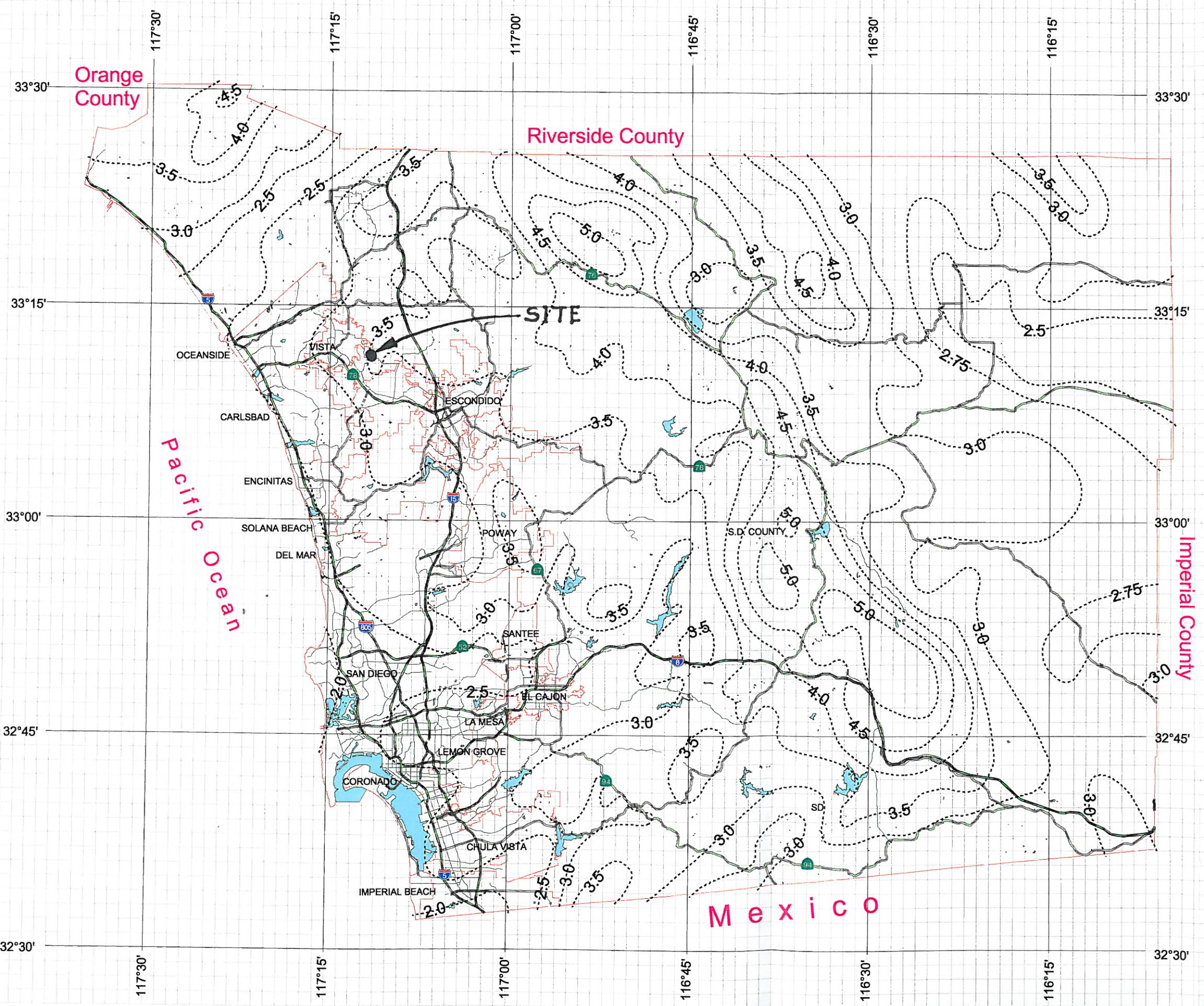
Critical depth .....	3.8804 in
Critical slope .....	0.0070 ft/ft
Critical velocity .....	2.2808 fps
Critical area .....	2.6142 ft <sup>2</sup>
Critical perimeter .....	197.9373 in
Critical hydraulic radius .....	1.9018 in
Critical top width .....	194.0220 in
Specific energy .....	0.6177 ft
Minimum energy .....	0.4850 ft
Froude number .....	2.7211
Flow condition .....	Supercritical

**APPENDIX 1**  
**ISOPLUVIAL MAPS**

# County of San Diego Hydrology Manual



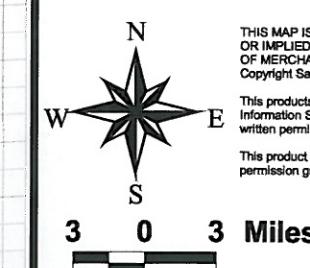
*Rainfall Isopluvials*



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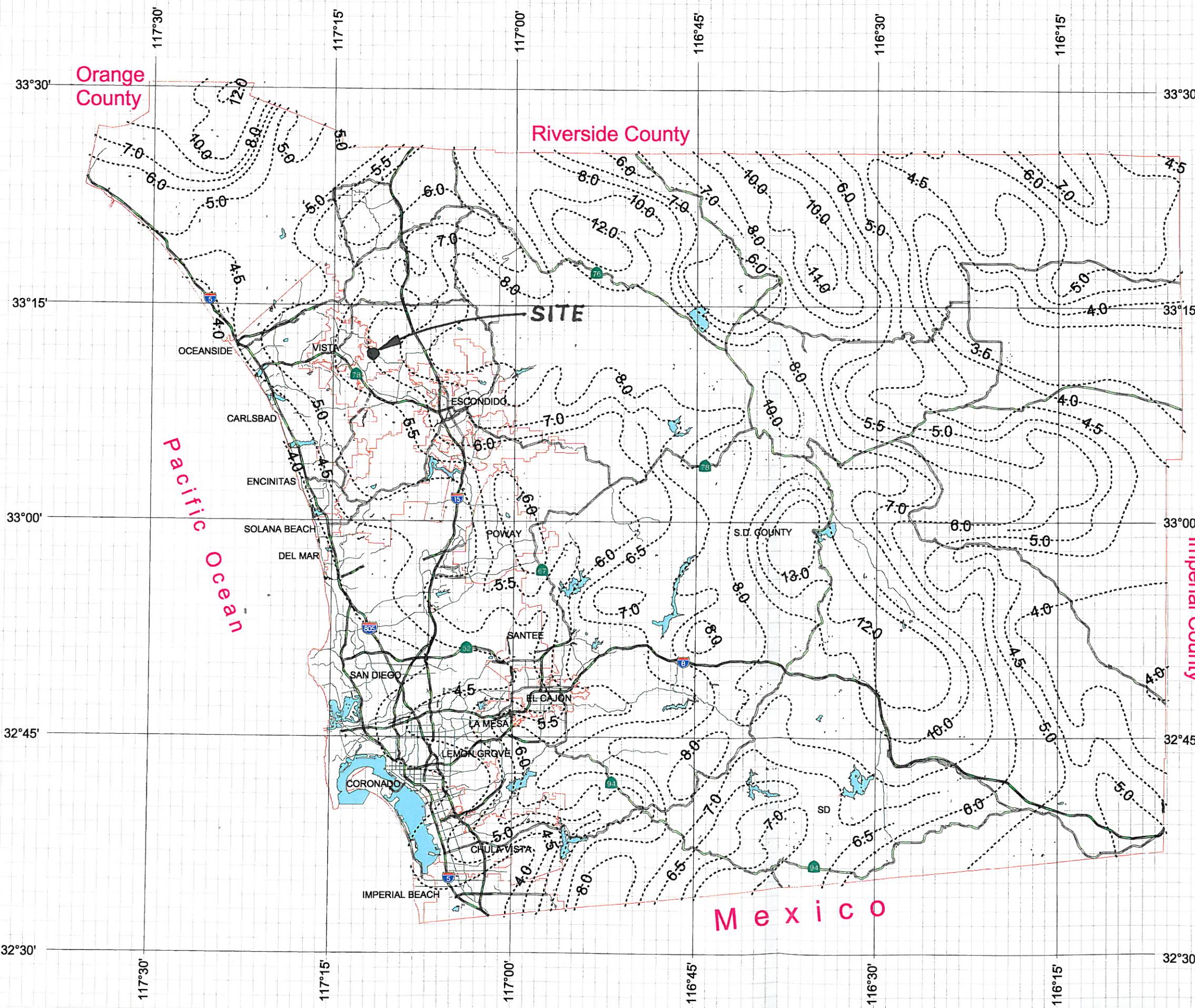
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# County of San Diego Hydrology Manual



*Rainfall Isopluvials*



**100 Year Rainfall Event - 24 Hours**

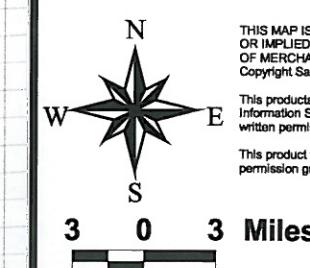
----- Isopluvial (inches)



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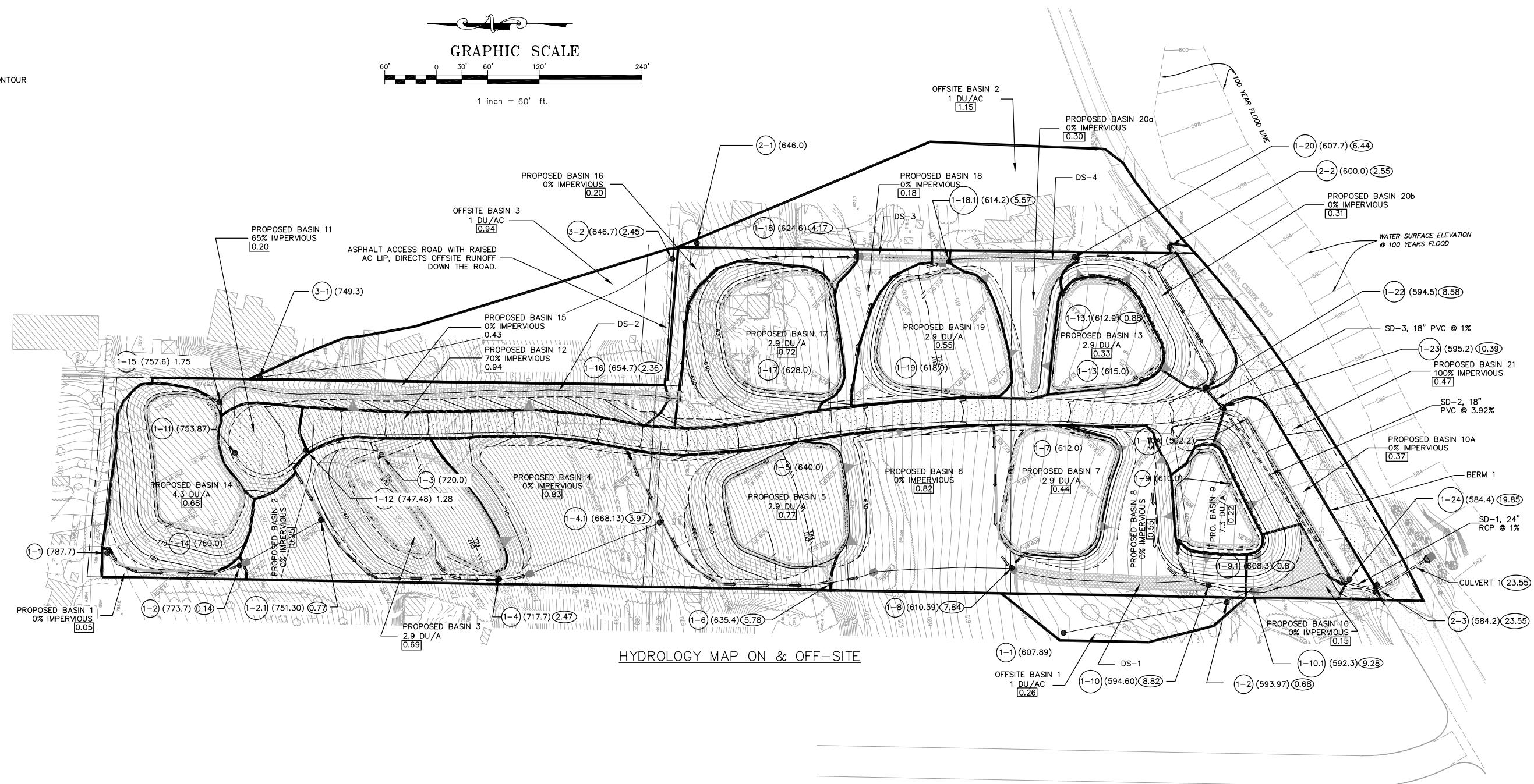
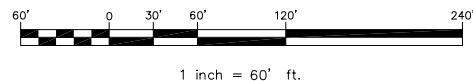


**APPENDIX 2**  
**HYDROLOGY MAP – DEVELOPED CONDITION**

## LEGEND

557.8	X
500	
0	
60'	
0	30' 60' 120' 240'
DS-1	
(1-2)	
(789.5)	
(0.66)	
(2.34)	

## GRAPHIC SCALE

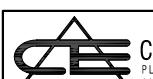
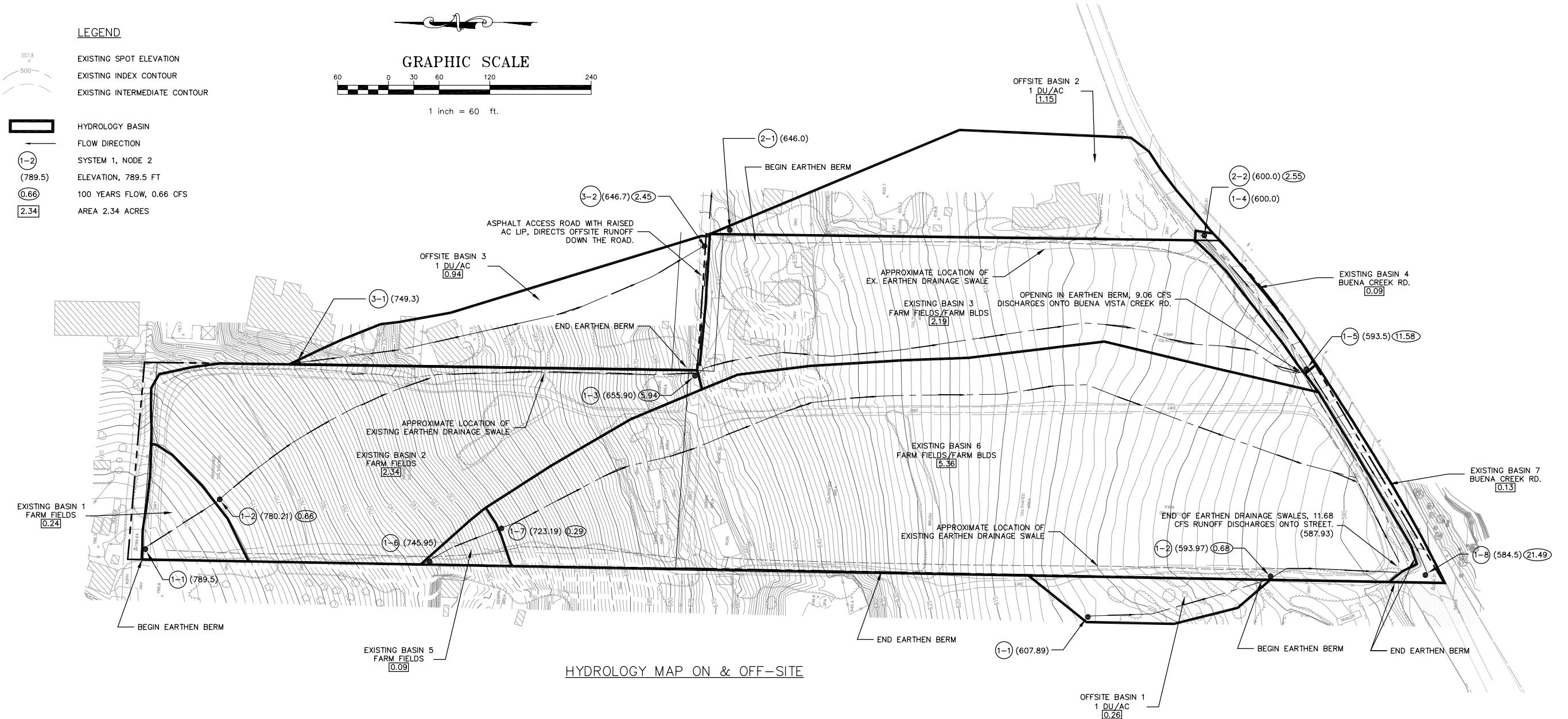


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PLANNING - CIVIL ENGINEERING - LAND SURVEYING - GEOTECHNICAL  
1441 MONTIEL ROAD, SUITE 115 ESCONDIDO CA. 92028, PH:(760) 746-4955

HYDROLOGY MAP - DEVELOPED CONDITIONS

CONSTRUCTION RECORD	REFERENCES	Date	By	REVISIONS	App'd	Date	BENCHMARK	SCALE	Office	Designed By	Drawn By	Checked By
Contractor _____	_____	_____	_____	_____	_____	_____	_____	Hor Scale _____	_____	Planned By _____	Drawn By _____	Checked By _____
Inspector _____	_____	_____	_____	_____	_____	_____	_____	Vert Scale _____	_____	Planned Under Supervision Of _____	Drawn By _____	Checked By _____
Date completed _____	_____	_____	_____	_____	_____	_____	_____	Traffic _____	_____	Date _____	_____	_____

**APPENDIX 3**  
**HYDROLOGY MAP – EXISTING CONDITIONS**



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ANNING - CIVIL ENGINEERING - LAND SURVEYING - GEOTECHNICAL  
41 MONTIEL ROAD, SUITE 115 ESCONDIDO CA. 92026, PH: (760) 746-4955

CONSTRUCTION RECORD	REFERENCES	Date	By	REVISIONS	APPROVAL
Contractor _____					
Inspector _____					
Date completed _____					

pp'd	Date

## BENCHMARK

SCALE

Office \_\_\_\_\_

	Design

ned By \_\_\_\_\_  
Plans Prep \_\_\_\_\_

Drawn By \_\_\_\_\_  
Prepared Under Super \_\_\_\_\_  
Date \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

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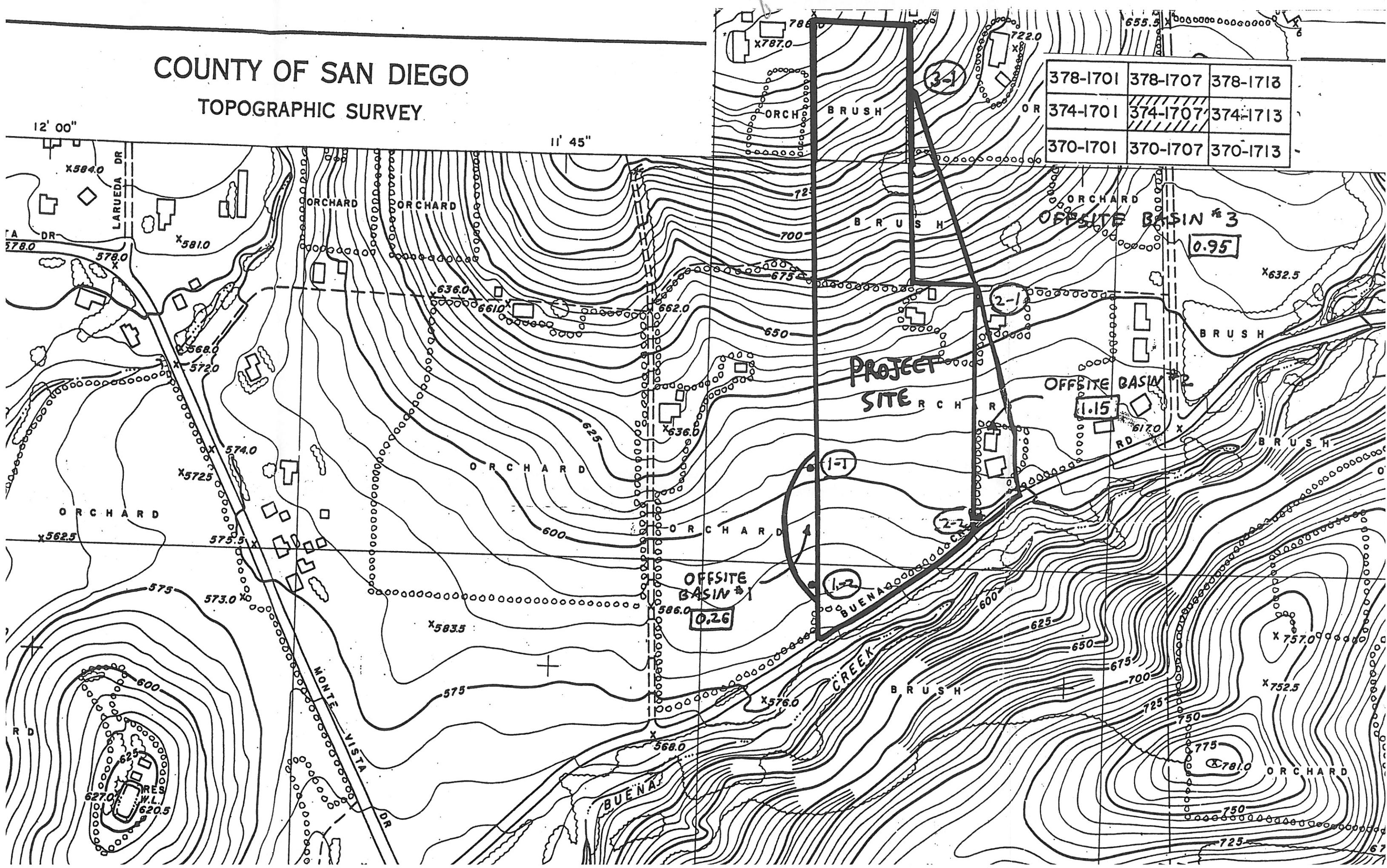
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HYDROLOGY MAP -PRE DEVELOPMENT CONDITIONS

Sheet No.

**APPENDIX 4**  
**HYDROLOGY MAP - OFFSITE**

COUNTY OF SAN DIEGO  
TOPOGRAPHIC SURVEY



**APPENDIX 5**  
**HYDROLOGIC SOILS GROUP MAP**

TABLE 11.--INTERPRETATIONS FOR LAND MANAGEMENT--Continued

Map symbol	Soil	Hydro-logic group	Erodibility	Limitations for conversion from brush to grass
LfE	Las Flores-Urban land complex, 9 to 30 percent slopes: Las Flores----- Urban land-----	D D		
LpB	Las Posas fine sandy loam, 2 to 5 percent slopes-----	D	Moderate 2----	Slight.
LpC	Las Posas fine sandy loam, 5 to 9 percent slopes-----	D	Moderate 2----	Slight.
LpC2	Las Posas fine sandy loam, 5 to 9 percent slopes, eroded.	D	Moderate 2----	Slight.
LpD2	Las Posas fine sandy loam, 9 to 15 percent slopes, eroded.	D	Moderate 2----	Slight.
LpE2	Las Posas fine sandy loam, 15 to 30 percent slopes, eroded.	D	Moderate 1----	Slight.
LrE	Las Posas stony fine sandy loam, 9 to 30 percent slopes.	D	Moderate 1----	Moderate.
LrE2	Las Posas stony fine sandy loam, 9 to 30 percent slopes, eroded.	D	Moderate 1----	Moderate.
LrG	Las Posas stony fine sandy loam, 30 to 65 percent slopes.	D	Severe 1-----	Moderate.
LsE	Linne clay loam, 9 to 30 percent slopes-----	C	Moderate 2----	Moderate.
LsF	Linne clay loam, 30 to 50 percent slopes-----	C	Severe 1-----	Moderate.
Lu	Loamy alluvial land-----	B	Severe 16----	Slight.
LvF3	Loamy alluvial land-Huerhuero complex, 9 to 50 percent slopes, severely eroded: Loamy alluvial land----- Huerhuero-----	D D	Severe 1----- Severe 1-----	Severe. Severe.
Md	Made land-----	D D	Severe 2----	Slight.
M1C	Marina loamy coarse sand, 2 to 9 percent slopes-----	D	Severe 2----	Slight.
M1E	Marina loamy coarse sand, 9 to 30 percent slopes-----	A	Severe 2----	Slight.
MnA	Mecca coarse sandy loam, 0 to 2 percent slopes-----	A	Severe 2----	Slight.
MnB	Mecca coarse sandy loam, 2 to 5 percent slopes-----	B	Severe 16	
MoA	Mecca sandy loam, saline, 0 to 2 percent slopes-----	B	Severe 16	
MpA2	Mecca fine sandy loam, 0 to 2 percent slopes, eroded-----	B	Severe 16	
MrG	Metamorphic rock land-----	D	Severe 1-----	Severe.
MvA	Mottsville loamy coarse sand, 0 to 2 percent slopes-----	A	Severe 2----	Slight. 4/
MvC	Mottsville loamy coarse sand, 2 to 9 percent slopes-----	A	Severe 2----	Slight. 4/
MvD	Mottsville loamy coarse sand, 9 to 15 percent slopes-----	A	Severe 2----	Slight. 4/
MxA	Mottsville loamy coarse sand, wet, 0 to 2 percent slopes.	D	Severe 2----	Slight. 4/
OhC	Olivenhain cobbley loam, 2 to 9 percent slopes-----	D	Severe 16	
OhE	Olivenhain cobbley loam, 9 to 30 percent slopes-----	D	Severe 16	Slight.
OhF	Olivenhain cobbley loam, 30 to 50 percent slopes-----	D	Severe 16	Slight.
OkC	Olivenhain-Urban land complex, 2 to 9 percent slopes: Olivenhain----- Urban land-----	D D	Severe 1-----	Moderate.
OkE	Olivenhain-Urban land complex, 9 to 30 percent slopes: Olivenhain----- Urban land-----	D D		
PeA	Placentia sandy loam, 0 to 2 percent slopes-----	D	Severe 9----	Slight.
PeC	Placentia sandy loam, 2 to 9 percent slopes-----	D	Severe 9----	Slight.
PeC2	Placentia sandy loam, 5 to 9 percent slopes, eroded-----	D	Severe 9----	Slight.
PeD2	Placentia sandy loam, 9 to 15 percent slopes, eroded-----	D	Severe 9----	Slight.
PfA	Placentia sandy loam, thick surface, 0 to 2 percent slopes.	D	Severe 16----	Slight.
PfC	Placentia sandy loam, thick surface, 2 to 9 percent slopes.	D	Severe 16----	Slight.
Py	Playas-----	D	Moderate 2	

See footnotes at end of table.

TABLE 11.--INTERPRETATIONS FOR LAND MANAGEMENT--Continued

Map symbol	Soil	Hydro-logic group	Erodibility	Limitations for conversion from brush to grass
VaB	Visalia sandy loam, 2 to 5 percent slopes-----	B	Severe 16----	Slight.
VaC	Visalia sandy loam, 5 to 9 percent slopes-----	B	Severe 16----	Slight.
VaD	Visalia sandy loam, 9 to 15 percent slopes-----	B	Severe 16----	Slight.
VbB	Visalia gravelly sandy loam, 2 to 5 percent slopes-----	B	Severe 16----	Slight.
VbC	Visalia gravelly sandy loam, 5 to 9 percent slopes-----	B	Severe 16----	Slight.
VsC	Vista coarse sandy loam, 5 to 9 percent slopes-----	B	Moderate 2---	Slight.
VsD	Vista coarse sandy loam, 9 to 15 percent slopes-----	B	Moderate 2---	Slight.
VsD2	Vista coarse sandy loam, 9 to 15 percent slopes, eroded.	B	Moderate 2---	Slight.
VsE	Vista coarse sandy loam, 15 to 30 percent slopes-----	B	Moderate 2---	Slight.
VsE2	Vista coarse sandy loam, 15 to 30 percent slopes, eroded.	B	Moderate 2---	Slight.
VsG	Vista coarse sandy loam, 30 to 65 percent slopes-----	B	Severe 1-----	Moderate.
VvD	Vista rocky coarse sandy loam, 5 to 15 percent slopes.	B	Moderate 2---	Moderate. 3/
VvE	Vista rocky coarse sandy loam, 15 to 30 percent slopes.	B	Moderate 2---	Moderate. 3/
VvG	Vista rocky coarse sandy loam, 30 to 65 percent slopes.	B	Severe 1-----	Moderate. 3/
WmB	Wyman loam, 2 to 5 percent slopes-----	C	Moderate 2---	Slight.
WmC	Wyman loam, 5 to 9 percent slopes-----	C	Moderate 2---	Slight.
WmD	Wyman loam, 9 to 15 percent slopes-----	C	Moderate 2---	Slight.

1/

Typically a grassland soil; conversion from brush usually not necessary.

2/

Moderate if slope is more than 30 percent, slight if less than 30 percent.

3/

Stoniness or rockiness not a serious impediment to use of grass-planting equipment.

4/

On desert-facing mountain slopes and in valleys, in the eastern part of land resource area 20, the degree of limitation is severe because of climate, regardless of soil properties.



APPENDIX 6  
ROUGHNESS COEFFICIENT CHARTS

## Table A-1

**Table A-1** Average Manning Roughness Coefficients for Pavement and Gutters<sup>1</sup>

Concrete Gutter <sup>2</sup> .....	0.015
Concrete Pavement	
Float Finish.....	0.014
Broom Finish.....	0.016
Concrete Gutter with Asphalt Pavement	
Smooth Finish.....	0.013
Rough Texture.....	0.015
Asphalt Pavement	
Smooth Finish.....	0.013
Rough Texture.....	0.016

Based on FHWA HEC-22.

<sup>1</sup> Based on materials and workmanship required by standard specifications.

<sup>2</sup> Increase roughness coefficient in gutters with mild slopes where sediment might accumulate by 0.020.

**Table A-2****Table A-2** Average Manning Roughness Coefficients for Closed Conduits<sup>3</sup>

Reinforced Concrete Pipe (RCP) .....	0.013
Corrugated Metal Pipe and Pipe Arch	
2-3/8 x 1/2 inch Corrugations	
Unlined .....	0.024
Half Lined	
Full Flow .....	0.018
$d/D \geq 0.60$ .....	0.016
$d/D < 0.60$ .....	0.013
Fully Lined .....	0.013
3 x 1 inch Corrugations .....	0.027
6 x 2 inch Corrugations .....	0.032
Spiral Rib Pipe .....	0.013
Helically Wound Pipe	
18-inch .....	0.015
24-inch .....	0.017
30-inch .....	0.019
36-inch .....	0.021
42-inch .....	0.022
48-inch .....	0.023
Plastic Pipe (HPDE and PVC)	
Smooth .....	0.013
Corrugated .....	0.024
Vitrified Clay Pipe .....	0.014
Cast-Iron Pipe (Uncoated) .....	0.013
Steel Pipe .....	0.011
Brick .....	0.017
Cast-In-Place Concrete Pipe	
Rough Wood Forms .....	0.017
Smooth Wood or Steel Forms .....	0.014

<sup>3</sup> Based on materials and workmanship required by standard specifications.

**Table A-3****Table A-3** Average Manning Roughness Coefficients for Small Open Channels Conveying Less than 50 cfs<sup>4</sup>

Lining Type	Design Flow Depth		
	0 – 0.5 ft	0.5 – 2.0 ft	> 2.0 ft
Concrete (Poured)	0.015	0.013	0.013
Air Blown Concrete	0.023	0.019	0.016
Grouted Riprap	0.040	0.030	0.028
Stone Masonry	0.042	0.032	0.030
Soil Cement	0.025	0.022	0.020
Bare Soil	0.023	0.020	0.020
Rock Cut	0.045	0.035	0.025
Rock Riprap	Based on Rock Size (See Section 5.7.2)		

**Table A-4****Table A-4** Average Manning Roughness Coefficients for Larger Open Channels

<b>Unlined Channels</b>	
Clay Loam.....	0.023
Sand .....	0.020
<b>Lined Channels</b>	
Grass Lined (Well-Maintained) .....	0.035
Grass Lined (Not Maintained) .....	0.045
Wetland-Bottom Channels (New Channel) .....	0.023
Wetland-Bottom Channels (Mature Channel).....	See Table A-5
Riprap-Lined Channels .....	See Section 5.7.2
Concrete (Poured).....	0.014
Air Blown Mortar (Gunite or Shotcrete) <sup>5</sup> .....	0.016
Asphaltic Concrete or Bituminous Plant Mix .....	0.018

For channels with revetments or multiple lining types, use composite Manning roughness coefficient based on component lining materials.

<sup>4</sup> Based on materials and workmanship required by standard specifications.

<sup>5</sup> For air-blown concrete, use  $n=0.012$  (if troweled) and  $n=0.025$  if purposely roughened.

## Table A-5

**Table A-5** Average Manning Roughness Coefficients for Natural Channels

**Minor Streams (Surface Width at Flood Stage < 100 ft)**

Fairly Regular Section

(A) Some Grass and Weeds, Little or No Brush .....	0.030
(B) Dense Growth of Weeds, Depth of Flow Materially Greater Than Weed Height .....	0.040
(C) Some Weeds, Light Brush on Banks.....	0.040
(D) Some Weeds, Heavy Brush on Banks .....	0.060
(E) For Trees within Channel with Branches Submerged at High Stage, Increase All Above Values By .....	0.015

Irregular Section, with Pools, Slight Channel Meander

Channels (A) to (E) Above, Increase All Values By .....	0.015
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Mountain Streams; No Vegetation in Channel, Banks Usually Steep, Trees and Brush along Banks Submerged at High Stage

(A) Bottom, Gravel, Cobbles and Few Boulders.....	0.050
(B) Bottom, Cobbles with Large Boulders.....	0.060

**Flood Plains (Adjacent To Natural Streams)**

Pasture, No Brush

(A) Short Grass .....	0.030
(B) High Grass .....	0.040

Cultivated Areas

(A) No Crop .....	0.040
(B) Mature Row Crops .....	0.040
(C) Mature Field Crops.....	0.050

Heavy Weeds, Scattered Brush

Light Brush and Trees .....	0.060
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Medium To Dense Brush.....

Dense Willows .....	0.090
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Dense Willows .....

Cleared Land with Tree Stumps, 100-150 Per Acre.....	0.060
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Heavy Stand of Timber, Little Undergrowth

(A) Flood Depth below Branches .....	0.110
(B) Flood Depth Reaches Branches .....	0.140

APPENDIX 7

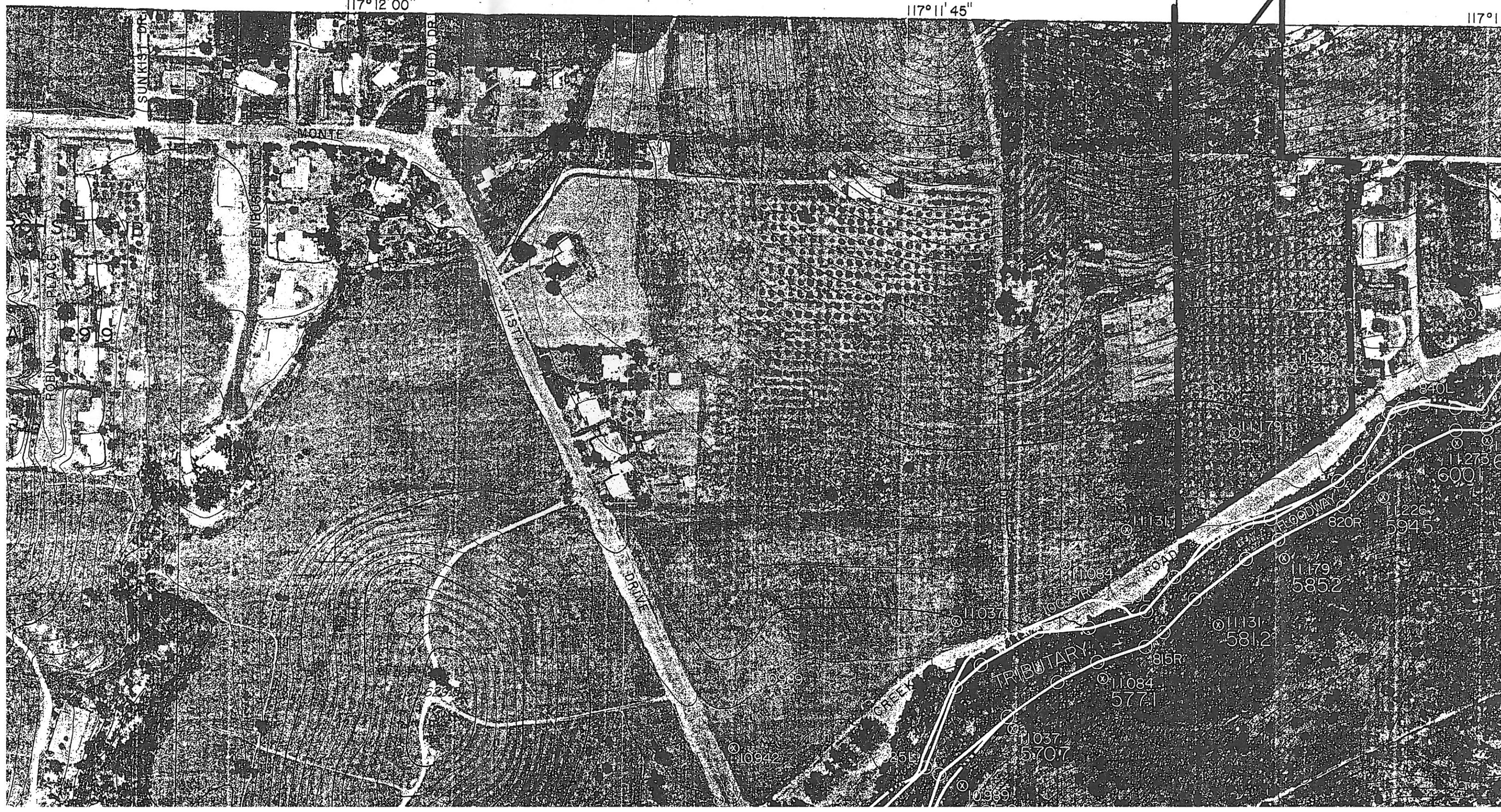
BUENA CREEK 100-YEAR INNUNDATION MAP  
&  
HAC-2 CALC SHEETS.

# COUNTY OF SAN DIEGO FLOODPLAIN MAP

117°12'00"

117° 11' 45"

-SITE



2500.	0.	2500.	0.	0.	256.	0.	277.	85.	581.8	
.79	0.00	9.76	0.00	.045	.045	.045	.041	574.10	150.50	
.017433	230.	246.	280.	2	0	0	0.00	75.20	225.70	

2

FLOW DISTRIBUTION FOR SECNO= 11-13 CVSEL= 581.1

STA = 151. 229.  
PFR Q = 170.0  
DFA = 256.2  
VEL = 9.5

\*SECNO 11.179

11.18	6.47	585.17	0.00	0.00	586.81	1.64	4.16	.03	587.60
2500.	0.	2500.	0.	0.	243.	0.	278.	85.	589.1
.80	0.00	10.27	0.00	.045	.045	.045	.041	578.60	200.77
.016937	255.	242.	230.	2	0	0	0.00	64.38	265.15

FLOW DISTRIBUTION FOR SECTION 11-18 CASEL = 585.1

STA = 201. 277.  
PFR Q = 100.0  
ARFA = 243.0  
VEL = 10.0

#SECNO 11.226

SECNO	DEPT	CSEL	CRTR	NSFLK	FG	HV	HI	LOSS	RANK ELE
0	0100	0CH	0R0R	A10R	ACH	AR0R	V0I	TWA	LEFT/RIGHT
TIME	VI 00	VCH	VR0R	XNI	XNCH	XNR	WTN	FLMIN	SSTA
SI DPF	XI 00	XLCH	XI 0R8	JTRIAI	IDC	ICONT	COPAR	TOPWID	ENDST

3685 20 TRIALS ATTEMPTED NSFL + CNSFL

3693 PROGRALF MINIMUM SPECIFIC ENERGY

3720 CRITICAL DEPTH ASSUMED

11.23	7.43	594.53	594.53	0.00	596.57	2.05	4.61	.08	597.40
.2500.	0.	2500.	0.	0.	218.	0.	280.	86.	602.5
.81	0.00	11.42	0.00	.040	.045	.045	.042	596.90	257.42
.019524	240.	254.	260.	20	8	0	0.00	53.17	310.59

FLOW DISTRIBUTION FOR SECNO= 11-23 CWSEL= 594-51

STA = 257. 333  
 PFD 0 = 100.0  
 ADFA = 217.8  
 VEL = 11.5

\*SFCNO 11-272

SFCNO	DEPTL	CALIFI	CRTXIS	WSFLX	FG	HV	HL	DLOSS	RANK ELE
Q	0100	0C	0R0R	AI0R	ACh	AR0R	V0I	TWA	LEFT/RIGHT
TIME	VI00	VCR	VR00	XN1	XNC4	XNP	WTN	ELMIN	SSTA
SLOPE	XLCI	XLCR	XLO/R	LIRIA	IDC	ICONT	CO2AP	TORWID	ENDST

7185 MINIMAL SPECIFIC ENERGY

3720 CRITICAL ASSESSMENT

11.27	6.00	600.10	600.10	0.00	601.85	1.75	4.82	.03	609.10
2500	0.	2500	0.	0.	235	0.	287	86	614.7
<del>P</del> = .81	<del>100</del>	10.63	0.00	.045	.045	.045	.042	594.10	236.22
<del>A</del> = .270	<del>240</del>	220.	3	15	0	0.00	68.93	305.15	
- 10207.07									

	X2	0.000	0.000	1.000	445.000	448.000	448.000	448.000	448.000	448.000	448.000	448.000
STA	236.	234.										
PER Q=	100.0											
AREA=	235.2											
VEL=	10.6											
0.020707	270.	240.	220.									
								15	0	0.00	68.93	305.15

FLOW DISTRIBUTION FOR SECNO= 11.27 CWSFL= 600.10

STA= 236. 234.  
 PER Q= 100.0  
 AREA= 235.2  
 VEL= 10.6

\*SECNO 11.285

SECNO	DEPTH	CWSFL	CRIWS	WSFLK	FG	HV	HL	LOSS	RANK ELEV
0	0.00	0CH	0R0R	A1OR	A1CH	AR0R	V0I	TWA	LEFT/RIGHT
TIME	VI.00	VCH	VRO+	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XI.00	XLCH	XI.0RR	TTRPAI	TDC	TCONT	COPAR	TOPWTD	ENDST

3685 20 TRIALS ATTEMPTED WSFL=CWSFL

3693 PROBABLE MINIMUM SPECIFIC ENERGY

3720 CRITICAL DEPTH ASSUMED

11.22	10.61	604.31	604.31	0.00	606.50	2.19	1.17	.09	603.60
2500.	12.	2488.	0.	5.	209.	0.	281.	86.	610.20
.81	2.24	11.91	0.00	.045	.045	.045	.042	594.30	214.22
0.018370	55.	60.	55.	27	14	0	0.00	57.33	271.54

FLOW DISTRIBUTION FOR SECNO= 11.29 CWSFL= 604.31

STA= 214. 229. 243.  
 PER Q= .0 99.5  
 AREA= 5.2 204.0  
 VEL= 2.2 11.9

\*SECNO 11.321

SECNO	DEPTH	CWSFL	CRIWS	WSFLK	FG	HV	HL	LOSS	RANK ELEV
0	0.00	0CH	0R0R	A1OR	A1CH	AR0R	V0I	TWA	LEFT/RIGHT
TIME	VI.00	VCH	VRO+	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XI.00	XLCH	XI.0RR	TTRPAI	TDC	TCONT	COPAR	TOPWTD	ENDST

7185 MINIMUM SPECIFIC ENERGY

3720 CRITICAL DEPTH ASSUMED

11.32	9.77	609.37	609.37	0.00	611.38	2.02	3.63	.02	611.50
2500.	0.	2500.	0.	0.	219.	0.	282.	86.	613.00
.92	0.00	11.39	0.00	.045	.045	.045	.042	599.60	198.61
0.020963	145.	185.	185.	5	8	0	0.00	54.47	253.08

FLOW DISTRIBUTION FOR SECNO= 11.32 CWSFL= 609.37

STA= 199. 259.  
 PER Q= 100.0  
 AREA= 219.4  
 VEL= 11.4

\*SECNO 11.368

SECNO	DEPTH	CWSFL	CRIWS	WSFLK	FG	HV	HL	LOSS	RANK ELEV
0	0.00	0CH	0R0R	A1OR	A1CH	AR0R	V0I	TWA	LEFT/RIGHT
TIME	VI.00	VCH	VRO+	XNL	XNCH	XNR	WTN	ELMIN	SSTA